

[No. 76.]

[PRINTED FOR THE USE OF THE COMMISSIONERS ONLY.]

SECOND SERIES.

Metropolitan Sewers.

CONCISE STATEMENTS

OF

THE MAIN FEATURES

OF

THE PLANS

FOR

THE DRAINAGE OF THE METROPOLIS,

SENT IN PURSUANCE OF THE RESOLUTION OF THE COURT, 20TH AUGUST, 1849.

JOHN ADAMS, Esq., A.I.C.E.

11, Park Street, Westminster,
25th September, 1849.

LONDON is situate in a basin.

The River Thames is the natural drainage of this basin.

The present greatest limit of fall for existing sewers is to low-water mark, some 18 feet 6 inches below Trinity datum, and about 16 feet below the ground surface at Deptford, Lambeth, and Battersea.

The present supply of water is weak and deficient.

It appears to me that the grand objects to be desired, are to get an unlimited supply of water, with heavy pressure, *entirely* under the control and direction of the

[SECOND SERIES.]

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Commissioners at all times ; a greater fall for the sewers, and a constant discharge, let the state of the tide be what it may ; to maintain comparatively fresh air in the sewers ; to keep the Thames free from drainage manure ; and to turn such manure to some beneficial and profitable account.

I propose to accomplish these objects in the following manner :—

First, As to sufficient fall, and constant flow in the drains. My plan would be to sink receivers, at desirable points on the sides of the Thames, between high and low-water marks, and carry them down any depth that might be required, and build them up above high-water mark, to prevent the tide flowing into them. The main sewers to discharge into them as low down as may be necessary to give the required fall for a constant flow (see accompanying sketch), and to employ sufficient engine-power to pump the manure from these receivers, to be carried by iron pipes alongside turnpike roads and railways, where practicable, and in other directions into different counties, for general agricultural purposes.

Secondly, A good and plenteous supply of water, I propose to get from the River Thames, by lifting engines at, say Hammersmith and Limehouse, or Black-wall ; and to form reservoirs at eligible spots round London, to be supplied by these engines, sufficiently elevated to scour any and all the sewers, and to supply water at any requisite places for ordinary purposes, as the Thames water, by such a scheme, would be comparatively pure. If this plan is adopted, the sewers may have a sufficient scour every twenty-four hours, and thereby prevent noxious gases and accumulations of fermenting matter ; and such scouring might be made to act upon the house drains, as well as the general sewers, which I consider one great thing to be aimed at ; in fact, I think the flushing should commence in the house drains.

I would propose, the pipes supplying the reservoirs be carried straight from reservoir to reservoir.

The engines at the waterworks would also lift the manure into the pipes for the country.

I believe, with the aforesaid improved fall, constant flow, and ample supply of scouring water, that comparatively small sewers will be sufficient for the drainage of the Metropolis.

Other engagements, and shortness of time, have prevented my giving more than a cursory outline of my views.

I have the honour to be,

My Lords and Gentlemen,

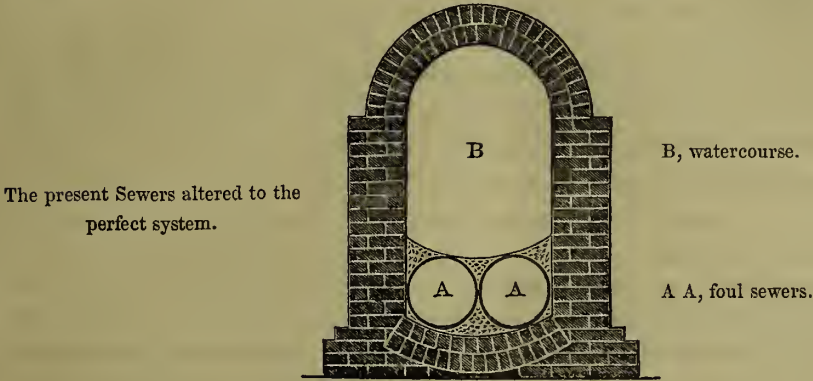
Your most obedient Servant,

(Signed)

JOHN ADAMS, A.I.C.E.,
Engineering Surveyor, &c.

WILLIAM BARDWELL, Esq.

[This statement was, by accident, omitted in the First Series. It belongs to a plan sent in to the Commissioners at the first sittings of the new Commission in November, 1847; and again, in compliance with the order of the Court, 20th August, 1849.]



My Lords and Gentlemen,

THE perfect system of drainage appears to be this : that THE PRESENT SEWERS SHOULD BECOME CLEAN SUBTERRANEAN WAYS, affording a receptacle for the foul sewers, a passage for the sewers-men, and a conduit for the surface drainage ; that deep intercepting sewers shall be constructed which shall convey all offensive matter to stations remote from the centre of the Metropolis, into which deep sewers the contents of the foul sewers should be *always running*, while the surface, or rain water, would pass over into its natural receptacle, the river. Hence we shall have a ready means of examining and of flushing the foul sewers when necessary ; the prevention of stench in the streets ; the preservation of the waters of the river from pollution ; the great sewers so clean that any lady might traverse them ; and, on getting rid of the smoke, the air of London nearly as pure as that of the country.

The peculiarity of the plan and surface outline of the Metropolis causes the sewers most conveniently to arrange themselves for our purpose into three nearly equal divisions, each having its separate intercepting sewer and depôt for the sewage manure.

My proposed intercepting sewer of the first division, coloured red on plan, commences at Trafalgar-square, receiving a tributary from Waterloo-bridge, and, running along Whitehall, Parliament-street, Millbank, Lupus-street, Chelsea Hospital-gardens, Cheyne-walk, and Cremorne, empties itself at a depôt near the

Counter's Creek, a length of $4\frac{1}{4}$ miles, which line may be advantageously extended to Fulham Common, and receive the sewage of Hammersmith.

The second, coloured blue, commences at Villiers-street, and runs along the Temple-gardens, Earl-street, Thames-street, the back of the Tower, East Smithfield, St. George's, Shadwell, the East India Dock-road, to a depôt in Bromley Marsh, a length of five miles.

The third, coloured yellow, commences at the Effra, near Vauxhall-bridge, and runs along Vauxhall-row, High-street, Lambeth, the Palace-gardens and New-road, York-road, Stamford, Sumner, and Tooley-streets, Jamaica and Paradise-rows, to its depôt at Bermondsey, a length of $4\frac{1}{4}$ miles, which sewer may be extended to Woolwich.

As any lower than low enough involves a wasteful expenditure, these sewers would be laid five feet lower than the lowest sewer in its division, with a fall of one foot in a mile; and as it would be unwise to construct a sewer so small that, being always full, it could not be examined or repaired, the form of these sewers would be a true ellipse, on a foundation commencing with a height of five feet six inches, and a width of three feet, gradually increasing to a height of seven feet, and a width of five feet. The material, Stourbridge lumps, or, what is best of all for hydraulic works, the limestone of Limerick. Thus, these sewers may undoubtedly be executed as easily as any other common sewer.

In 1834 the quantity of water supplied by all the water Companies was $5\frac{1}{2}$ million cubic feet per day. This is now supposed to be augmented to nine millions, but of this more than one-half must be absorbed or evaporated; we may therefore conclude that six million cubic feet will be the maximum quantity in the foul sewers; and, very probably, data in this office will show that it would be much less; while the matter held in suspension and in solution in the present sewers is 1 in 400, or $2\frac{1}{2}$ oz. of dry solid matter in each cubic foot, which may possibly increase to four oz. in the improved sewers.

The termini, or depôts, will consist of a sump, into which the sewers will be continually running, and from which the sewage will be pumped up into tanks; these to consist of four, of a capacity of one million cubic feet each, or 12 hours' sewage, so that 24 hours may be allowed for subsidence and clearing deposit, and one tank be always at rest; the fourth to contain the overplus and the sewage for irrigation at the proper seasons. The bottoms of the tanks will be four feet above low water, and the sides 20 feet high, so that the clear water may run itself off into the river. Each charge of 12 hours' sewage will leave a deposit of upwards of 100 tons. The area of the tanks and sump will be about half an acre, and the area

of the whole establishment four acres, as there must be large warehouses for storing the manure, offices, &c.

The termini are remote from dwellings, and convenient for the water carriage of the poudrette. The dealing with 200 tons of manure daily at each dépôt will require a great number of hands, as some of the manure must be casked, some bagged, and some sent away in bulk. Each will become an important commercial station, *incessantly in action*, with cash receipts of £4,000 a week, altogether demonstrating the impracticability of dealing with the immense mass of six million cubic feet of matter at one point only. Nor have I yet met with any writer at all aware of the manipulation required to turn out 600 tons of manure daily.

	£
The 13½ miles of intercepting sewer will cost £10 a yard	237,600
Compensations and casualties	50,000
	<hr/>
	287,600
	<hr/>
Each terminus will cost as follows:—	£
Four acres of ground at £500	2,000
The tanks and sump and roofs of do.	13,372
Warehouses, engine-house, offices, &c.	30,000
Two engines of 60 horse-power each, at £4,000	8,000
	<hr/>
	53,372
	<hr/>

The return obtainable for this outlay will be 200,000 tons of poudrette, worth at least £3 a ton, or £600,000; and, deducting one-sixth for expenses, will leave a clear profit of £500,000 a year, without noticing the money derivable from irrigation. I have calculated the manure as sold at £3 a ton, but the Manure Company with which I am connected sell their manure at £5, and this is retailed in the country at £7 or £8 a ton. Moreover, it is an ascertained fact that the product of the Hartshorn-lane sewer alone is worth more than £50,000 a year.

Lime is the common and usual disinfecting agent, but lime would deprive the manure of its ammonia, and thereby deteriorate its quality. If electricity should prove inconvenient, the chymical agents I propose are simple, plentiful, and cheap, such as would add to the fertilizing qualities of the sewer deposit, and completely deodorize it, while at the same time the supernatant water would become chymically pure and clear as that from any spring.

The works at each dépôt may be in operation within a few months from this date, as the tanks would be the first portion of the work completed, and the contents

of the nearest sewers received; then proceeding onwards until the whole sewerage were absorbed.

The same system may be carried out in every city and town in the kingdom, where a small engine would disperse the sewage for irrigation around the adjoining country.

“In offering this plan,” which I have been maturing for years, “to the notice of this Honourable Court, I do so with the desire of having it submitted to the fullest and most impartial inquiry,” assured that its practicability and advantages will be apparent to your experienced intelligence, while the immense mass of facts accumulated by your Commission, if brought to bear upon it, will unquestionably ensure its successful accomplishment, as it is obviously a plan which may be readily carried out with the *smallest possible outlay, the largest return, and permanent efficiency.*

I have the honour to be,
My Lords and Gentlemen,
Your obedient Servant,
(Signed) WILLIAM BARDWELL.

4, Great Queen-street,
St. James's Park.

HENRY H. BIRD, Esq.

5, Robert Street, Adelphi,
October 13th, 1849.

My Lords and Gentlemen,

IN compliance with the desire expressed in a notice received by me, from the Secretary of your Honourable Court, I beg to submit the following statement on those points which constitute the principal features of the scheme for the drainage of the Metropolis, which I submitted to your notice in the month of August.

Firstly. My plan will embrace the whole district within the jurisdiction of the Metropolitan Commission.

Secondly. It is intended to secure at all times a good outfall for the sewage of the Metropolis, irrespective of the ebb and flow of the tide in the River Thames.

Thirdly. It will preserve the River Thames free from any pollution of its waters by the sewage of the Metropolitan districts.

Fourthly. It will scarcely, if at all, interfere with the existing sewers, as at present constructed.

Fifthly. The main sewers proposed to be built will be at all times easy of access, and can, if required, be readily repaired, without interfering with the passage of the sewage.

Sixthly. The size and inclination of the main sewers will be sufficient to carry off, not only the existing sewage, but a considerably larger quantity, which may be anticipated to arise from an increase of population.

Lastly. The sewage will be collected in reservoirs, at some distance from any inhabited district, and converted into solid manure, fit for agricultural purposes, or a portion, if desired, retained in a liquid form for distribution.

The mode by which I propose to arrive at the foregoing results, is by laying sewers built of brick, in cement, and coated with asphalte, along both sides of the River Thames, from Twickenham to Barking or Plaistow Levels, on the North side, and from Kew to Plumstead Marshes, on the South side. These sewers would vary somewhat in form and in size (from 16 feet of sectional area to 156 square feet), in different parts of their course, and, with the exception of some few deviations from the line of the river, for the purpose of shortening the distance, would be constructed in the bed of the river, below the level of low-water mark. The fall would increase more rapidly than that of the river, the amount of inclination being however limited, so as not to occasion any interference with the upper side of the Thames Tunnel at Rotherhithe. Shafts at certain distances would be erected, to give a ready admission to the interior of the sewers; for destroying chemically any noxious gases that might be generated, and which, unless got rid of, might interfere with the passage of the sewage; and for flushing occasionally, at high water, the interior, to prevent the accumulation of sediment.

The sewers would be, for the greater portion of the distance, constructed of a double form, so that, when desired, the sewage might for a time be caused to flow in either channel, while the other underwent cleansing or repair; this might be done either for the whole length or merely for any length, between two of the shafts.

At the termini at Barking or Plaistow, and at Plumstead Marshes, reservoirs would be constructed, of considerable extent, for the reception of the sewage, which after being pumped up to a higher level, would be separated from the water, and the latter passed into the river when the tide was on the ebb.

My plan does not embrace any interference with the present system of sewers, otherwise than by repairing them where in decay, securing connection between them

and all adjoining houses, and by trapping, in the most eligible manner, the gully-holes. It is, however, manifest, that the carrying into effect the channels for securing a continuous outfall, could not interfere with any improvements that could hereafter be effected in the minor sewers; the mouths of all the latter would, of course, either be lowered or connected by pipes with the main channels.

I propose that the lower ends (or those adjoining Barking or Plaistow, and Plumstead Marshes,) should be first commenced; by which method each portion, as soon as completed, could immediately be brought into use, without the delay requisite for the completion of the whole. This system would have the effect of commencing a purification of the river at an early period, so that in the course of from two to three years (when the whole work should be finished), the amount of fresh water passing out at every ebb-tide, would have entirely cleansed it. A further advantage gained would be a saving of manure, collected while the work was in progress.

Conciseness being desired, as far as practicable, in this paper, I am unable to enter upon any explanation of the means I should propose for getting rid of the impediments which may at first appear to militate seriously against the execution of this plan; but although I foresee impediments (to which, however, all plans must be liable), I yet apprehend none but which could, without much difficulty, be surmounted.

For more detailed particulars, estimate, and reasons for recommending the adoption of this plan, I must beg leave to refer your Honourable Court to the statement and sections of proposed main sewers, already furnished by me; and, in conclusion, I would venture to observe, that whatever the merits or demerits of my scheme may be, it is not, at all events, of very recent origin, as it was proposed by me, and submitted privately to many persons, professional and otherwise, four years since, with a view to its being carried into effect through the medium of a Joint-Stock Company.

I have the honour to be,

My Lords and Gentlemen,

Your most obedient Servant,

(Signed)

HENRY H. BIRD.

The Honourable Court of Metropolitan Sewers.

J. BOWRON, Esq.—(VISCATA.)

My Lords and Gentlemen,

THE general principles on which my plans are founded, are very simple: and by describing each portion separately, in as brief a manner as possible, will, I think, give you the best idea of the whole plan I have proposed.

In the first place, I propose that two principal sewers or tunnels be formed, through which the whole of the sewage of London may be conveyed from the town to some distant part in the suburbs, where it can be disposed of, as I shall afterwards describe. The first, or principal tunnel, will be on the North side of the River Thames, commencing at Acton, as marked on the plan in black, passing to the South of Buckingham Palace, along the Strand, Fleet-street, the South side of St. Paul's, along Watling-street, and continuing, as marked on the plan, to the Marshes at West Ham.

The dimensions of this tunnel, at its commencement at Acton, to be 4 feet by 2 feet 6 inches, and to continue of those dimensions until it reaches the point where it crosses the Brentford-road; then taking the dimensions of 5 feet by 3 feet 3 inches, which dimensions it maintains until it reaches the King's-road, Chelsea, where it will be 6 feet by 3 feet 6 inches: these dimensions will continue to St. James's-park, to the point where it receives the Paddington sewage: the dimensions will then be 7 feet by four feet. At Farringdon-street it will take its largest dimensions, which will be 10 feet by 7 feet, which will continue to the West Ham Marshes, where it is divided into four divisions or heads, with appropriate wells for the discharge of the sewage; to be pumped off by engines; each well to have an engine, about 500 horse power, and to have four large tanks, with one smaller one, to receive the sewage from the engine. The two tanks joining the small receiving tank, are for the collection of solid sewage intended for manure, from which the liquid sewage passes into the third tank, through flood-gates, which will be constructed so that portions of it can be closed, as the solid sewage increases in depth in the collecting tank. These portions will be closed by means of a lever, which one man can attend to, being of very simple construction.

The liquid sewage will pass from the third tank, through sluice-gates, into a bed of broken stones, four feet in thickness, and separated from another bed of sand and gravel, by an iron grating, so that the broken stones may be taken away when they become foul, and replaced with others, without disturbing the sand and gravel, which will be 100 feet in length; then another iron grating and bed of broken stones, as before. By this means the liquid sewage will be so filtered, that it may be taken to the Thames without any injury to the river. For cleansing, repairs, &c., each engine is provided with double sets of tanks, as shown on the small supplementary plan.

The gradual fall of this tunnel will be about four feet per mile, which I consider sufficient, if constructed on the following plan.

The first length, from Acton to Brentford, to be constructed in the same manner as the present third-class sewers, with the addition of glazed stoneware, to line the bottom and about one-third of each side. The glazed stoneware to be made in

lengths of three or four feet; the bottom to be two feet wide, and curved the shape of the sewer, as shown in the transverse section of the sewer in the margin. The side pieces to be made to the same radius as the sides of the sewer. This stoneware to be one inch in thickness, with joints at the edges, as shown at B on the transverse section; to be bedded in the brick-work in cement. The other portions of the tunnel to be lined in the same manner. By this mode of construction the sewage will flow over a smooth surface, and have no obstruction in its passage; therefore, no accumulation of solid matter can take place, but will be carried off with the sewage water, through the whole length of the tunnel, which is about sixteen miles.

All secondary sewers to be constructed as at present, with the addition of the glazed stone lining. These may be classed, first, second, and third-rate sewers, according to the district of sewage each will have to receive. A number of those sewers I have marked on the plan in blue, amounting in length to about 140 miles. It might be found necessary, in the course of construction, according to different levels, to have a greater quantity of those drains or sewers.

The house drains to be glazed pipes, four, five, or six inches in diameter, according to the size of house to be drained; each to have two sets of drains, one for the sink and water-closet, the other for the rain or surface-water.

The street drains to be glazed stone pipes, from twelve to twenty-four inches in diameter, according to the length of street and number of houses required to be drained by them; these and the house drains will constitute the collecting drains, which will empty themselves into the secondary sewers, which convey it direct to the principal tunnel.

The main tunnel, as marked on the map, for the south side of the Thames, to be constructed in the same manner as the one already described, having two divisions with wells, tanks, and engines, the same as the other.

The main tunnels and secondary sewers I propose to ventilate, by means of air shafts at the most convenient places. These shafts to be of two kinds; one for the admission of air into the tunnel and sewer, to be constructed with a cowl on the top, to collect the air, and drive it into the sewers; the other will be constructed with a furnace to draw off all the foul air, and consume all noxious gases it may contain.

All cesspools to be emptied and filled up, and the houses that have not got water-closets to have them attached, and the present accommodations, such as privies, &c., to be taken down or converted into water-closets, if properly situated, and can be made available. Every house used as a common lodging house, to be inspected at intervals by the Surveyor of the district in which such house is situated,

to be provided with at least two water-closets; and I should also have such houses provided with some mode of disposing of the ashes and dirty water contiguous to their own apartments. My motive for this suggestion is, that when employed in surveying houses of this description for repairs, &c., I have found that the parties occupying top-rooms, garrets, and second floors, have provided themselves with baskets and large pans, or tubs, which will contain the whole of the ashes and dirty water they may have accumulated during the week, and never think of emptying them until they are full; and I am fully convinced that houses of this description will not be kept in any order of cleanliness without the adoption of some plan or other for the better discharge of such refuse. The plan I here propose is to supply each house of this description with water and a sink-stone to each landing on the staircase, the sink-stones to be very small, in the shape of a funnel, to be used only for the discharge of refuse water, for which purpose it will have a pipe attached to a main pipe communicating with the sink drains in the kitchen; and by means of a wooden pipe, or square box fixed to the wall, outside the house, the ashes may also be conveyed to the dust-bin, in the manner shown in the section No. 2 in the margin, the entrance to be on the landing of the stairs, the same as the water supply. A represents the trap when open to receive the ashes, and B represents it when shut. The two water-closets I should recommend to be situated, one on the kitchen, or basement floor, and the other on the first floor of each house of this description.

The surface water to be excluded, as far as possible, from all sewage drains and sewers collecting it for manure, such water to be carried off by the present existing drains and sewers, except in cases where the present sewers may be made available to act as future sewers; in those cases pipe drains must be laid to take off the surface water to the nearest old sewer used for that purpose; these sewers will empty themselves into the Thames, as at present.

The supply of water requires a serious consideration and very great attention, both with regard to quality, quantity, and the best method of distributing it, as on this rests the principal part of cleanliness in houses; the present intermitting supply is very defective, and most particularly in thickly inhabited neighbourhoods, where there are large houses let out by the occupier in separate rooms, each room containing a small (and in some cases a large) family, with a cistern or water-butt that will not hold more than is sufficient for about seven persons, when the house contains four or five times that number; this butt, when the supply is laid on, will be full in about ten minutes or a quarter of an hour, and, having no ball-cock attached, the water still runs at full force during the remainder of the time, which is an hour, and sometimes an hour and a half. In one of the best localities I have observed the supply to an eight-roomed house with a large cistern sufficient to hold an abundant supply for the inmates, this cistern I have seen filled in twenty minutes, and the remainder of the time the water has been running off down the waste-pipe; and it is my

opinion that not above one ball-cock in ten throughout London acts as it ought to do, therefore I may safely say that two-thirds of the present supply runs down the drains; and if a constant supply were substituted by means of pipes, and dispense with the cisterns and water-butts, it would not require more water for the supply than it does at present; the sewers can also be more effectually cleansed with much less water than what runs through them at present; the tunnels I have proposed will be much below the level of the present sewers, consequently the secondary sewers proposed will have a much greater fall than the present sewers, and, if lined with the glazed stone-ware, will want very little, if any, flushing.

A constant supply of water can easily be obtained from different localities round London; the Hampstead and Highgate hills present a most desirable place for the purpose, on the north side of the Thames; reservoirs could be made on these hills to contain an abundant supply, which could be taken to all parts on that side the Thames.

These reservoirs I propose to supply from the New River Company, the Hampstead Company, from Hendon, and from the Thames at or about Henley, to be conveyed by channels as far as possible, and from thence by engines to the reservoirs, the water to be properly filtered before it reaches the engines; from these places an abundant continual supply may be obtained without the assistance of land drainage.

The south side of the Thames can be supplied from the river Wandle and the Thames, with reservoirs on Brixton-hill and Norwood, on the same principle as those already described for the north side of the Thames.

The surface or land drains for Westminster, if a particular drain was formed and the water collected to one main tank, might be pumped off into the Thames by engine, the drains to be constructed of broken stones and perforated stone-ware pipes, as shown in the margin, section No. 3; a stone-ware pipe laid in the centre, and filled up to the height of two feet with broken stones, as at A on the section, the top of the pipe and the sides perforated, to admit the water into the pipe after it has collected in the broken stones.

I am, Gentlemen,

Your obedient servant,

(Signed)

J. BOWRON.

3, Pembroke-terrace, Caledonian-road,
Islington.

Sir SAMUEL BROWN, R.N. K.H.

To the Right Honourable and Honourable the Commissioners of Sewers, the accompanying Plans, Specifications, and Estimates for the preserving the purity of the River Thames, and the more efficient drainage of the Metropolis, are respectfully submitted by CAPTAIN SIR SAMUEL BROWN, R.N.K.H. &c.

Vanburgh Lodge, Blackheath,
October 12, 1849.

Sir,

I DULY received your letter of the 2nd instant, communicating the resolution of the Court of Sewers, that the authors of each plan that had been sent in after the 20th of August, should be requested to send in, if they should see fit, a concise statement of their principle and details, in order that they may be printed for the use of the Court. Conceiving that the above resolution applies to those plans which had been received on the 20th of August, as well as to others, which had been subsequently delivered, I beg leave to state, that the principal feature of the plans, which I have now the honour to submit to the consideration of the Court, consist, in laying down tubular wrought iron drains on both sides of the river, to any desired extent, trenched to a certain depth below the surface, so that there would be a fall of nearly four feet in a mile from the summit level of both tubes near Battersea Bridge, to their outlets at the point of Hookness, and opposite, in Woolwich Reach.

The localities on both sides, being peculiarly adapted for the proposed undertaking, any line between high and low water would be equally suitable for laying down the tubes; but it is submitted, that the best course to follow would be to sink the tubes close to the facing of all the wharves, which necessarily partake of the relative level of high water, and consequent declivity of low water level on both sides of the river, and as the tubes would require to be protected by a continuous row of piles, a valuable extension of wharfage would not only be required, but vessels of considerably larger burthen, which are now only accessible by stages, or the intervention of floating piers, would come close along aside of the wharves; and this appears to me so important and easily attained an object, that I have constructed a model showing both the principle and details of the plan, which, if required, I will be happy to explain to the Court. But, abstractedly considered in an engineering point of view, there could not be a better course than to follow within the winding and undulations of the proposed embankment, reported to the Court of Common Council by the Thames Navigation Committee in 1842.

It has been observed, that the summit level of both tubes on both sides of the banks of the river, is formed a little below Battersea Bridge, where two hydraulic forcing pumps are erected for injecting with great force 50,000 cubic feet, or

upwards of 12,000 tons of Thames water in an hour, which is nearly equal to the whole of the house sewage collected in the tubes, for scouring down the sewage and other matter collected in the tubes, and on the south side the discharge of the scouring water would be proportionate to the capacity of the tube.

The strong red lines on the plan marked No. 1, show the direction of the tubes under ground, running parallel with the embankment of the river, proposed in 1842. Following this line on the shores on both sides, passing through the inner arches of all the bridges close to their respective abutments, and continued on this line with a declivity of four feet in a mile to the uppermost pier of the St. Katharine's Docks, where it falls suddenly to the depth of ten feet across the entrance, which is one foot below the sill of the gates, consequently causes no impediment to the entrance of the ships of the largest tonnage. The fall from thence is three feet ten inches in a mile, crossing the entrance of the London Docks to Limehouse Creek, where it is turned in with an easy bend, and crosses to the private Dock, commonly called the Fore and Aft Dock, crosses under Fore-street, under the middle of Park-street, at the head of which it crosses the Commercial-road, proceeds under Penny-fields, to the East India-road, which it leaves at the Custom House, passing under a considerable extent of uninhabited market-garden ground, crosses the river at the bridge, from thence it is continued to Hookness, a point in the Plaistow Marshes, where the great outfall will be formed. Extreme length of the tube, including the bends of the river, $9\frac{1}{2}$ miles.

During the progress of these works, a connection will be formed by impermeable pipes of sufficient dimensions with all the drains which now discharge into the river with the tubular sewers, the mouths of which would be hermetically closed, so that even in the lowest levels in Westminster, and the eastern parts of London, and the whole of the south side of the Thames, their noxious contents, which are thrown back and glutted by the influx of the spring tide, will be effectually prevented, and precautions will be taken to admit of the escape of the water during great land floods, by means of valves fitted to the upper part of the mouth-plate, which would be impervious to the pressure from without, but would open to the preponderating pressure within, should the storm water in any extreme case rise to that height, and which would not in the most remote degree contaminate the purity of the river, because all the offensive matter would have been previously precipitated through the transverse pipes into tubes below. As the confluence of the whole of the drainage of the Metropolis with the Thames would be entirely cut off and thrown into two comparatively narrow channels, it must be placed beyond the possibility of doubt, in the minds of the most competent judges, that the tubes should be sufficiently capacious to meet every emergency.

It appears from the official reports respecting the system of drainage of London and the suburbs, published about eight years ago, that upwards of

1,500,000 of cubic feet of ground sewerage, and other matter, was produced and discharged into the river in the course of twenty-four hours; and it is computed by Mr. Phillips, Chief Surveyor to the Court of Sewers, who must necessarily be possessed of the best means of information, that the daily produce, and discharge of the drainage from the Metropolis, on both sides of the river, now amounts to about 2,000,000 of cubic feet.

The sectional area of the tube on the north side, at the Grosvenor Canal is 40 square feet, the mean section 70 feet, and at the extreme end 100 feet; and its extreme length from the head, at the mouth of the Grosvenor Canal, including the winding of the river to Hookness, in the Plaistow level, is $9\frac{1}{2}$ miles. The sectional area of the tube on the south side is 64 feet; the extreme length from a point opposite to the Grosvenor Canal, to a point opposite to Hookness, in the Plumstead Marshes, is the same distance of $9\frac{1}{2}$ miles; the total length of both tubes being 19 miles; and the declination on both sides, from the summit level of the tubes to the bottom of the shafts of the outlets, is four feet in a mile, as before stated, being nearly three feet more fall than the bed of the river.

It has already been observed that precaution has been taken to permit of the escape of the storm water at the mouths of the sewers. Assuming, therefore, the gradient to the tubes, and their sectional area of 100 feet at the outlets as the data, they will be capable of carrying off 20,000,000 of cubic feet of sewerage, or ten times more than is produced and discharged into the river in twenty-four hours; in addition to this immense excess of capacity of the tubes, the impetus which this stream of matter would acquire in this descent, would be accelerated with irresistible velocity by a powerful jet of water from hydraulic engines, erected at the heads of the tubes on each side of the river, and this new feature in the plan naturally suggests the idea that the same means may be applied with most salutary effect in purifying the house sewerage, and scouring down all the great trunk drains of London, which, in this more fluid state, would be rapidly precipitated into the lateral tubes below, and put an end to the system of flushing the drains in their own contaminated matter, and suppress the consequent noxious exhalations.

As this measure is not submitted as a substantive proposition, I will beg permission to advert to it in a supplementary communication.

From what has been before stated, it must necessarily follow, that whatever amount of sewerage and other matter is thrown into the lateral tubes, there must be adequate means to dispose of it at all the outlets.

I believe Mr. Phillips has taken the safe side in estimating the production and discharge of the drainage of all London at 2,000,000 of cubic feet in twenty-four hours;

the amount of hydraulic scouring water can be computed to a certainty, because it can be at all times adjusted to the requirement. Assuming, therefore, Mr. Phillips' estimate of 2,000,000 of subsoil drainage would be daily discharged into the tubes, and an equal quantity of pure scouring water would be at the same time forced in by the engines, at the head of the tubes there would be a daily discharge at the outlet of 4,000,000 of cubic feet.

The sectional area of the tubes would, at the outlet, be 100 cubic feet; the velocity of this stream of matter, accelerated by the scouring water, would be three miles an hour; from these data the main tube will be capable of discharging upwards of ~~34~~ 3,000,000 of liquid matter, or eight times more than is formed in the north Metropolis; and there would be a proportionate excess of capacity in the tube on the south side.

It must necessarily follow, that whatever the amount of sewage is conveyed into the lateral tubes from the common sewers, there must be adequate means of disposing of it at the outlet; to meet this exigency, it is proposed to erect two hydraulic engines of 200 horse each, or four smaller of adequate power; and as the lift is only about fifty feet, the engines would be capable of raising nearly 26,000,000 of cubic feet in twenty-four hours, to be distributed into barges, or land carriages; the surplus would be discharged into the river at certain periods of the tide, or run off by a sluice through the bank, as shown at figure 11, letter Y, on plan. As the primary object of these designs is to preserve the purity of the river Thames, it is obvious that the further up they are carried, the more effectually will they accomplish that end, for the system may be extended to Teddington, at a comparatively small expense.

I would here observe, that the adoption of wrought-iron tubes is no longer a principle, when the dimensions and peculiar position will admit of their being made of more fragile material; and if the Commissioners should now, or at any future period, entertain the measure, I would submit that the terminus of the iron tubes be at the mouth of the Grosvenor Canal, and that earthenware pipes may be used for that purpose; that is to say, if they had been found to be cheaper and preferable. But as the object is merely prospective, I have not included it in my estimates.

With respect to the downward course of the tubes, I am of opinion, that wherever the river water becomes brackish and unfit for domestic purposes, that there the tubes should end. There is not a drop of water used for this purpose at Deptford, or Greenwich; but we should gain nothing by following the course of the river and forming the outlets in Greenwich Reach, where the water first becomes undrinkable, for it has already been shown by the map, in connection with the line which I have proposed, that nature and art may be combined in a remarkable degree for facilitating the execution of this great sanitary measure; for where the cities are

the most densely populated, the line of embankment proposed in 1842 is the best course to follow in sinking the tubes, and where a deviation necessarily occurs, cutting off the bends of the river materially shortens the distance, and facilitates the operation. The districts on both sides are comparatively uninhabited; in fact, the great outlet at the point of Hookness in the Plaistow Level, is three miles nearer St. Paul's, which is the centre of London, than by water from London Bridge.

I have before observed, that the best direction for laying down the tubes, would either be close to the frontage of all the wharfs above or below the bridges, or within the proposed line of embankment reported in 1842.

When the Lords Commissioners of the Admiralty, and the high City authorities contemplated this important undertaking, they would necessarily have in view the more effectual drainage of London, and the preservation of the purity of the River Thames; it is therefore humbly suggested that the completion of those works being the precursor, would essentially promote this great national improvement.

In submitting these plans to the consideration of the Court, I have not presumed to draw any comparison with the propositions of more eminent projectors; but as I lost no time in availing myself of the resolution of the Court of Sewers, which appeared in *The Times* of the 24th of July last, I believe I may claim the small merit of priority in the presentation of my plans, but which gives them no practical superiority over others who have sent in similar or modified designs. But, in reference to my own previous humble labours, I may be permitted to say, that, notwithstanding the magnitude of the proposed works, that either in an engineering or mechanical point of view, they are simplicity itself, compared to some works which I have projected and carried into effect, and therefore I would have no hesitation, with the able co-operation which I can command, to undertake the whole of these works, and to complete them to the entire satisfaction of the Commissioners, in two years.

In conclusion, I beg leave to state, that with a view of facilitating the examination of the plans which were received on the 20th of August, I beg permission to lay before the Court, two copies of the same design on a smaller scale, which are described in detail in the accompanying concise specification.

I beg leave to add, that I would be happy to communicate any other information upon the subject personally, which the Commissioners may require.

I have the honour to be, Sir,

Your most obedient and very humble Servant,

(Signed)

SAMUEL BROWN.

Captain Royal Navy.

JOHN HENRY CLIVE, Esq.

Clanway Colliery,
Tunstall, Staffordshire.

THE main features of my amended plan are—

To separate the surface waters and rain floodings from the night-soil and liquid refuse of houses and places of business; because the surface waters are three times the quantity of the house drainage, and carry with them into the sewers a great quantity of gravel and useless dirt; and because the surface waters do not injure the salubrity of the Thames:

To allow the surface waters to flow into the Thames by means of the channels in great part already provided:

To have an open out-fall for the house-drainage above high-water mark;—*my plan insists on such an out-fall:*

To remove the night-soil and liquid refuse from the houses as fast as it arises, allowing no cesspools, and to discharge what cannot be profitably disposed of immediately, into the lower river beyond the precincts of the town:

To provide for a subsoil or foundation drainage, in connection with the house-drainage:

To provide stations and facilities to contracting parties, for the application of the sewage to profitable purposes, in portions as it is formed:

To provide for the dilution of the sewage, for cleansing the channels, for dredging up solid deposits, and for ventilation.

I make the following assumptions for the purposes of my plan; I assume—

That the area of the Metropolis is sixty square miles, (60): that the population of this area is two and one half ($2\frac{1}{2}$) millions: that the house-drainage does not exceed one cubic foot per day per individual: that the rain waters discharged over this area average (10,000,000) ten millions of cubic feet per day: that every house have a constant and sufficient supply of water, this being a first condition of good drainage: that every house have communication with the tubular drains.

The means I propose to take to effect the foregoing objects are the following:—

To construct two principal underground impermeable channels or culverts, open at both ends, and with open outfalls beyond the precincts of the Metropolis, and above high-water mark, one on each side the river Thames, as receptacles and conduits for all the house-drainage of the Metropolis.

These main culverts I propose to commence as far westward as Brentford and Richmond, and to tail out, with an open outfall, into the river Thames, above high-water mark, at such points below Woolwich as may from the levels and local circumstances be found most suitable.

This plan insists on an *open outfall above high-water mark*, as most advantageous and essential to perfection in any plan, such an outfall being at work, both for ventilation and discharge at all seasons, without artificial power or expense beyond the first outlay.

The dimensions of these culverts I have estimated from a consideration of the whole quantity of sewage, and the probable quantity that will be intercepted and sent into the country in a short time, and the quantity that for a period must run waste into the lower river or sea; and deem a size of four and one-half ($4\frac{1}{2}$) feet average diameter at the influx, and five and one-half ($5\frac{1}{2}$) feet average diameter at the outlet, as sufficient. And I reckon the expense of each of these main culverts, including shafts, inlets, outlets, ventilating chimneys, dredging swamps, and extracting stations, at not exceeding twelve thousand pounds (£12,000) per mile.

I would make the sectional form of these culverts elliptical, and construct them chiefly with impermeable archbricks, set in cement, nine inches in thickness of wall. And it is probable occasions may occur where it will be expedient to make them of iron for short distances.

To cause a current, these culverts must have as great an ascent from the outfall as the levels of the land will judiciously permit, with openings at intervals for receiving and extracting the sewage, ventilation, admission of diluting and cleansing waters, and dredging up deposits.

I ventilate these culverts by means of the engine and other chimneys, after the ready and effective method oftentimes used in coal mines.

The exact lines of these culverts cannot be laid down until after a minute survey, the principle is to take the line of lowest practicable surface ground, which will be near to the Thames at Wandsworth, the Strand, the Commercial-road, and Greenwich.

All house drainage from above, or on higher levels than these main culverts, I intend shall flow into them by the current of gravity, through smaller branch culverts, and impermeable earthen pipes, none less than four inches diameter, such pipes to diverge into every lane, alley, court, and row of inhabited buildings; and, for the purposes of subsoil drainage, such diverging pipes to be laid upon, or in juxtaposition with suitably formed draining tiles.

All house drainage coming from deeper or lower levels than these main culverts, I intend to collect through like branch culverts, pipes, and draining tiles, much on the converging system recommended by Mr. Austin, in February, 1848, and to force the same by engine power into these main culverts.

I have not estimated the expense of works for collecting the drainage on this converging system, but Mr. Austin states it to be about fifty pounds (£50) per acre, exclusive of engine power; and I estimate that two hundred horse power will raise all the lower ground drainage, at a cost of less than four thousand pounds (£4000) a-year, every engine to be made auxiliary to ventilation and raising solid deposits.

The main culverts being thus arranged to receive all the drainage, I would establish a number of stations whence, by contracting parties, the sewage might be extracted and sent into the country for agricultural purposes; one such station is already founded at Fulham, by the Metropolitan Sewage Manure Company, and is in successful operation.

I estimate that it will require twelve hundred (1200) horse power engines to force the whole of the sewage in a liquid (its best) form into the country, and in consequence of the surface waters being mostly kept out of the main culverts, and stations and facilities (not engine power) being provided, I would charge for the sewage a progressive rent up to one hundred pounds (£100) per horse power per annum, equal to about one halfpenny per ton, thereby tending to improve and cheapen farm produce, and producing to the Commissioners a rental of one hundred thousand pounds (£100,000) a year, exclusive of the Sewage Manure Company, who, by Act of Parliament, have the sewage of an assigned district free of charge.

The principles of this plan do not involve any engineering difficulties, and in so highly necessary and useful an undertaking, I would adopt *the best principle*, without regard to expense in the first instance, and then carry out that principle in the most economical manner, consistent with durable efficiency.

I would submit all the plans offered to uninterested competent judges, amongst whom should certainly be men *practically* acquainted with the draining of mines, cutting tunnels, and such like works.

As some plans will probably contain valuable features not in others, I would associate the authors of valuable portions in a "Board," with small fees, each to look after his own particular point, with power of individual appeal to the Commissioners in cases of dispute or doubt.

October 11, 1849.

(Signed)

J. H. CLIVE.

RICHARD GEORGE COKE, Esq.

THE following is a brief description of the Hydraulic plan for the effectual drainage of the City of London.

On referring to the drawing [*see original manuscript*], it will be seen that the propulsive power is to be derived from a pressure of water in vertical piping, C, which is delivered into a reservoir at B, either from a high level, or by the action of a steam engine or tide wheel from the Thames; and this, descending into the horizontal pipe, acts on the travelling piston D with a force equal to the height of the column C, which is of an altitude to give an effective pressure of 30 lbs. on each square inch of the piston.

The branch sewer G receives the drainage from the houses, and the surface water from the streets, and is connected to the main tube every 200 yards; and when a removal of the deposit is necessary, the valves at I are closed, and the water admitted on the back of the piston D, which it puts in motion, and carries the contents to a convenient place of discharge; and, as the water does not mix with the sewerage, it remains unimpaired as a manure, whereas, in the flushing system, the most valuable portion of it is lost. The tube being iron, no leakage can take place to render either the atmosphere or the springs of water noxious.

Should this force be inadequate, the valves E¹ and E² being closed, the engine would force the water directly into the tube, and any pressure may be obtained that could in safety be borne; the safety valve at F liberating the water to prevent injury to the pipes.

The piston D is packed on each external ring, and, to render it more secure, a quantity of soft packing is inserted between these rings, and as the ring L slides on the piston-rod it forces the packing to the side of the tube by the pressure on the piston, which thus becomes self-acting.

Under ordinary circumstances, the mere pressure of water at an altitude of ten feet would be ample to remove all deposit, but the distance being so great to convey the sewerage to, no flushing can ever answer, unless there is a great head of water

to force the sewerage along ; and brick sewers are totally inadequate to sustain this pressure, and thus the necessity of employing cast-iron pipes, which are not liable to decay as brick sewers are by the chemical properties of the drainage and the vibration of the road.

The reservoir in this plan is intended to be placed on the highest available point, and the sewer directed to the lowest.

The cost per lineal yard of the main tube, three feet six inches diameter, and three-fourths of inch cast-iron, the joints faced, would be £2. 15s., or £4,840 per mile.

The branch tube, 15 inches diameter, cost per lineal yard £1. 6s., or £2,288 per mile.

The cost of the excavations can only be ascertained by actual boring : the quantity of earth excavated will be considerably less for the iron tube than for the brick sewers.

The advantages this plan offer are—

Firstly. The complete removal of the sewerage without impairing its value as a manure.

Secondly. All cesspools, &c., are abolished, and the cartage of night-soil through the streets avoided.

Thirdly. The tube being cast-iron, no leakage can take place to render either the atmosphere or water impure ; and the accumulation of noxious gases is prevented.

Lastly. The cost of cleansing will be cheaper than by any known method. The piping, when once laid, will require no further outlay for repairs, and the streets will not be broken up as they now so frequently are where the sewers are constructed of brick in cement.

(Signed)

RICHARD GEORGE COKE.

Langton, near Alfreton,
Derbyshire.

COXWORTHY,—*See* DRAYSON.

JOSEPH CUNDY, Esq.

London, Oct. 1st, 1849.

My Lords and Gentlemen,

PRESUMING that the extirpation of the noxious gases arising from the sewers through the gully drains, the non-pollution of the Thames, and the profitable disposal of the products of the sewers for agricultural purposes, be the primary objects sought by your Honourable Board, I beg, respectfully, permission to submit for your consideration the accompanying plans and sections, with this explanation, as calculated to accomplish the desired object.

Firstly.—I beg to recommend that 250 ventilating shafts, having an air space all round the shafts, to preserve the inner lining of the shaft in a high degree of temperature, by the exclusion of damp and cold, be erected in accordance with the plan and section No. 5. These shafts may be placed upon any convenient spots communicating by air channels with the sewers, for the purpose of drawing therefrom the noxious gases. That gas be used as the motive power, being cleanly and continuous in its application, night and day, without attendance. That hydraulic traps be used, as shown in plan and section No. 5, to trap the gully drains.

The practical effect which will be produced by the application of this principle will be, that a continuous stream of fresh air will be drawn down the untrapped gully drains into the sewer, thus diluting the noxious gases, and from thence into the ventilating shafts, where the noxious gas will be consumed in its passage through the numerous jets of gas issuing from concentric rings at the base of the shaft; and the current of heated air passing up the shafts will be assisted in its ascent by a metal tube, heated by jets of gas, near the mouth of the shafts, causing the ascending stream of air to be raised to so high a temperature, as to force it to ascend rapidly far above the mouth of the shaft, totally disinfected.

Secondly.—I beg to recommend that fifty close depôt stations be erected at the outlets, or as near as practicable to the present main sewers, in accordance with the plans and sections numbered 1, 2, 3, and 4, for the purpose of receiving the thirty million gallons per diem of the products of the Metropolitan sewers, capable of holding in the aggregate double that quantity; the noxious exhalations arising therefrom to be drawn off and consumed, by passing through numerous jets of gas connected with the chimney shaft, upon the principle of the ventilating shafts. That the depôt stations contain iron tanks, raised 12 feet above high-water mark, to hold in the aggregate, at each of the fifty stations, 765,000 gallons, into which the products of the sewers will be lifted by rotary buckets, discharging seventy-two gallons into the tanks each revolution. That a mixing apparatus be placed in each of the tanks,

worked by the engine, for the purpose of keeping the liquid products in a flowing state, which products will be from thence conveyed by iron pipes and discharged into close barges, the escape of the noxious gases being prevented by means of a hose attached to the barge, and fitting close over the nozzle of the pipe, whilst delivering the freight into the barge. That a small auxiliary sewer be constructed, extending from depôt station to depôt station, on both sides of the Thames, to receive and intercept from the river, all the intermediate wharf and other sewerage, and conduct it into the depôt stations, which will also have the effect of preserving the same level for the liquid products in each of the depôt stations, connected together by the auxiliary sewer. That two steam engines be erected at each station, of sufficient power to work the machinery in case of accident to either of them.

The practical results which will arise from the adoption of this principle will be, that the sewers may remain as at present constructed. That the sewerage will be effectually cut off from the Thames by the depôt stations, and by the aid of the auxiliary sewer. That the offensive emanations arising from the outfalls of the present main sewers, now existing to the annoyance of the immediate neighbourhood thereof, will be intercepted by and received into the depôt stations, and drawn from thence into the ventilating shaft, and there destroyed. That the distribution of the depôt stations over an extensive area, will enable the Commissioners to employ an adequate number of close barges, to convey away the products of each twenty-four hours, without inconvenience to the navigation, and at any state of the tide. That the sewerage of the low level districts on each side of the Thames will be improved by uninterrupted drainage into the depôt station wells, twenty-five feet below their present level, at all states of the tide.

Lastly.—I beg permission to recommend, that thirty plots of poor land, averaging 100 acres each, be purchased in suitable localities, in the counties of Essex, Kent, Middlesex, and Surrey, contiguous to the Thames and canals. That close barges, to convey away the products of the sewers from the depôt stations, be constructed with tram wheels (*see* plan No. 3). That filtering backs, or beds, be formed, and tram roads be made, in accordance with plan and section No. 6. That two locomotive engines be employed at each station, for the purpose of drawing the barges to the filter backs to deposit their freights.

The practical results which will arise from the adoption of this plan will be, that the Commissioners will possess an extensive and lucrative market, in numerous agricultural districts, for the sale of the residuum of the sewerage. That the liquid products of the sewers being deposited in filter backs, can be taken away by the agriculturists in its liquid state to irrigate the lands, or after it has become sufficiently dry to be carted away at leisure; or loaded into barges, for the purpose of being conveyed up the canals, to supply the agriculturists in the midland counties; also

shipped as ballast, by coasting and other vessels. That by the process of filtration in the backs, specially constructed for the purpose, having numerous sub-drains, as shown in plan and section No. 6, to convey away the filtered water from the backs, the residuum manure will be thereby greatly enhanced in value, and the quantity of 30,000,000 gallons of liquid products, per diem, will be reduced to the saleable quantity of 350 tons of solid manure, and 334 tons of two-thirds concentrated liquid manure, to be disposed of at each of the thirty deposit stations per diem. That the former will find a ready and increasing market in the midland counties, by means of the canals, and for ballast; and the latter will be readily purchased by the agriculturists in the immediate localities of the deposit stations, in competition with guano, at one eighth of its price, leaving a balance of £1,032,244 per annum at the disposal of the Commissioners, after defraying all expenses.

The accompanying plans are intended to embrace the following important desideratum, viz. :—

The total destruction of the fetid exhalations from the sewers.

The collection and conveyance away of the whole Metropolitan sewerage.

The preservation of the purity of the Thames water.

The profitable sale of the products of the sewers.

The principle being equally applicable to either large or small towns, and the works in accordance with the accompanying plans, can be completed either simultaneously or in sections, and be in full operation within six months from the present time.

FINANCIAL STATEMENT.

Presuming that there are 30,000,000 gallons of liquid products of the Metropolitan sewers every twenty-four hours, which divided into fifty depôt stations, gives an average of 600,000 gallons to be disposed of, at each station, every twenty-four hours.

The fifty depôt stations to contain on the average 1,000,000 gallons each, nearly double the average quantity of sewerage per diem.

Three iron tanks at each depôt station, to hold on the average 765,000.

Fifty close barges at each depôt station will convey away 612,000 gallons per diem.

Six ventilating shafts to every 40,000 square yards, embracing in the aggregate six miles by five miles, will require 250 ventilating shafts.

Thirty million gallons of liquid products of the sewers per diem, will produce each week 210,000,000 gallons, 170,000,000 gallons of which, when reduced by the process of filtration in the backs to 1-25th part of its bulk, will produce 3,274,076 tons of solid manure per annum; and the remaining 40,000,000 gallons, when reduced to one-third of its bulk, by the process of filtration in the backs, will produce 3,313,700 tons of partly concentrated liquid manure per annum, making 350 tons of solid manure, and 334 tons of partly concentrated manure, for sale per diem, at each of the deposit stations.

TOTAL ESTIMATED OUTLAY.

50 depôt stations, including the purchase of sites, averaging } £30,000 each.....	£1,500,000
2,500 close barges, at £200 each	500,000
60 locomotive engines, at £2000 each.....	120,000
30 deposit stations, including the purchase of 100 acres of poor } land, at £10,000 each	300,000
250 ventilating shafts, and contingent expenses, £500 each.....	125,000
50,000 feet of small auxiliary sewer, on the sides of the Thames, and } for diverting the sewers where found expedient	400,000
Trapping gully drains, and other contingent expenses	300,000
	<u>£3,245,000</u>

TOTAL ANNUAL EXPENDITURE.

Gas for 250 ventilating shafts, at per week £6 each	£78,000
50 depôt station engineers, at 30s. per week each	3,900
100 depôt station labourers, at 20s. per week each	5,200
2,500 bargemen, at 30s. per week each	195,000
60 locomotive engineers, at 30s. per week each	4,680
300 deposit station labourers, at 20s. per week each	15,600
10 inspectors of ventilating shafts, at 20s. per week each.....	520
Contingent expenses, at £200 per week	10,400
	<u>£313,300</u>
To 4 per cent. interest on £3,245,000, total outlay.....	131,400
To 8 per cent. interest on £3,245,000, total outlay, } Less the purchase of land, &c., £1,120,000 }.....	170,000
<u>£2,125,000</u>	
	<u>£614,700</u>

TOTAL ANNUAL RECEIPT.

By sale of 3,313,700 tons of two-thirds concentrated liquid manure, } at 5s. per ton	£828,425
By sale of £3,274,076 tons of solid manure, at 5s. per ton	818,519
	<u>£1,646,944</u>

ABSTRACT.

To annual expenditure	£614,700
To balance	1,032,244
	<u>£1,646,944</u>

I beg permission,

My Lords and Gentlemen,

To have the honour to remain your obedient Servant,

(Signed) JOSEPH CUNDY.

To the Right Honourable and Honourable the Metropolitan Commissioners of Sewers.

HENRY CHARLES DAUBENY, Esq.

To the Honourable Commissioners of the Metropolitan Sewers.

13, Wintoun Place, Blackheath Road,
Greenwich, 9th October, 1849.

Gentlemen,

IN compliance with your circular, I beg to send you my plan for the alteration of the Metropolitan sewerage.

All sewers ought to discharge themselves either into the source of a river, or somewhere else quite clear from all habitations. If the London sewers are made deep enough to discharge into the channel of the Thames, with the opening down the river, no air would ascend the mouths of the sewers, and they would clear themselves at every fall of tide, if there is a weight of water upon a higher level. It is well known, that where the air cannot pass, no smell will arise; for which reason all water-closets have a stink-trap constructed to prevent the passage of the air. This constitutes the main principle in my plan for drainage; and upon this principle only can you remove the constant, increasing evil, which never can be effected by machinery; nor will it be safe to sanction any contracts for manure, incurring, independent of first expenses, a compensation for future losses in cases of failure, which will inevitably follow. Place the sewers at convenient distances from each other down the river, and if possible construct a reservoir for water, upon a high level, more effectually to clear them out periodically. Not having access to public documents, I am unable to give a plan in detail. There are no doubt numbers of cesspools under

houses in London, that have been made very large, to save expense of emptying, and when full have been covered over, and a new one built, to avoid the nuisance occasioned by emptying. No cesspool ought to be allowed hereafter to be built; but for the future, every landlord ought to be compelled to furnish a long, deep cask, under each privy, equal in capacity to the usage of a given term of weeks, or months, to be taken away and emptied by the public scavengers; the cask placed under the back of the seat, in line with the fall of any substance, and a provision made, under the front, to conduct the water into a drain, or some other channel. These casks might be fitted with bungs, and removed at any time, which is practised in many parts of Paris. Along the banks of the river, I should propose driving piles, to buoy up a portion of the shore left bare at low-water; and the rest to be dug out and thrown up, so as to leave no part exposed to the sun at low-water. It might be left to the option of parties interested, to make floating docks for their barges, or raise the embankments, so that it be done to avoid the accumulation of filth on the banks. This would have little or no effect on the course of the river; it would add greatly to the appearance, and be very desirable to many in possession of the quays, and enable them to have their vessels always at a certain given height, for loading and unloading. Every landlord, letting his house to more than one family, ought to be compelled to make an equivalent provision. This would soon find its own level, by additional costs for removal within a certain period, and fines in case of neglect.

I have the honour to be,

Gentlemen,

Yours most respectfully,

(Signed)

HENRY CHARLES DAUBENY.

If the sewers are made over large, the force of the fall would be weakened. I should recommend iron pipes, from the channel of the river up to the first house-drain at least. No house, within a certain distance of the river, would need any receptacle for filth. The water would cleanse everything, as the nearer the river the greater the fall in the collateral drains.

JAMES DEAN, Esq.

*To the Secretary of Her Majesty's Commissioners for Improving and Extending the
Drainage and Sewerage of the Metropolis.*

Sir,

I AM favoured with your circular of the 5th of October instant, and having, on the 1st instant, directed a letter to the Honourable Board containing further explanation of my plans, I will now, in as concise a manner as possible, give the substance of that communication, with some further observations in relation to

the mode of conveying the sewage of the present sewers into the proposed tunnel-sewers, to the ventilation of the tunnels, and to the removal of any excretiæ that may by possibility form at the bottom of the tunnel-sewers. I propose also to show the way in which a supply of water may be obtained for the use of the poorer classes especially, and to flush the house drains and sewers generally.

Firstly, then, I propose that the sewage of the existing drains that are situate above the proposed tunnel-sewers shall enter the tunnel-sewers at about the centre of the side of the same, curving a little, at an angle of about forty-five degrees; those that may happen to be on a level with the bottom of the tunnel or below it, if any, to enter at the bottom of the sewers.

Secondly. I propose, as stated in my first report, to ventilate the tunnel-sewers by means of conical shafts, the aperture of each shaft to be at the bottom, of equal diameter with the sewer, and to be 18 inches in diameter at the top, to be placed in convenient situations, as near as may be half a mile from each other, and carried several feet above the neighbouring buildings; iron close doors of communication to be made in each shaft, so as to enable persons to enter the sewer for examination, and if necessary to remove excretiæ, or to place a series of endless chains therein to run over rollers attached to fans, which would be moved by the current of the sewage, the chains to run in grooved iron plates, laid on and fastened to the bottom of the sewers. Whether, if a gas light was to be applied to the gas arising from the sewage at the top of each shaft, it might have the effect of destroying the noxious vapour, I am not prepared to give an opinion on, but it may be worth considering.

Thirdly, for supplying water to the dwellings of chiefly the poorer classes, and flushing the sewers generally—I propose to erect steam engines of adequate power, by the side of the tunnel-sewers, at the proposed flushing ponds on the north side of the river opposite to Wandsworth, and in Battersea-park, to communicate respectively with two filtering reservoirs, of adequate dimensions, one to be formed on Primrose-hill, near the Regent's-park, on land belonging to the Crown, or on land near, belonging to Eton College, and the other on Brixton-hill, Surrey.

The iron main, or feeder, between the flushing pond on the north side of the river and Primrose-hill, to be three feet in diameter, the length being about six miles, and that on the south side of the river to be two feet in diameter, in length about $2\frac{1}{2}$ miles, the intermediate lands being nearly regularly inclined planes.

The engines to draw water from the flushing ponds, and force it up the mains to the filtering reservoirs, from whence, in a filtered state, the waters would become distributable as circumstances may require.

The reservoir on Primrose-hill would be elevated considerably above the houses in London and Westminster, and that on Brixton-hill would also be above the houses in Southwark; the water would, by its own gravitating power, supply all the apartments in every dwelling throughout those districts.

To aid the supply of water proposed to be taken from the river at the flushing pond on the north side of the river, I propose to sink an artesian well near to the steam engine, down to the first main-spring, and thence by boring to and into the chalk formation, so as to insure a large and constant supply of water to be pumped by the engine, either directly into the main feeder or into the flushing pond.

To supply the flushing pond in Battersea-park with water beyond that to be drawn from the river, I propose to collect, by means of an iron trough, a portion of the overflow of the water at the weir at Teddington Lock, on the Thames, and to convey the same by a 12-inch iron pipe from the Lock to the flushing pond in Battersea-park, the distance being about eight miles; or recourse may be had to an artesian well, as proposed for the other side of the river.

In dry seasons, or at low tides, or at some periodical flushing, the water from these mains may be withdrawn directly into the tunnel-sewers, their mouths at the filtering reservoir being each closed by a self-acting valve, which, from the great elevation of the reservoir and length of the mains, could not fail to remove every obstacle to the free flow of the sewage in each of the tunnel-sewers, from one end to the other, respectively.

I remain, Sir,

Your very obedient servant,

(Signed)

JAMES DEAN.

Tottenham, 8th October, 1849.

J. BAILEY DENTON, Esq.

THE course of proceeding adopted by your Consulting Engineer, in departing from the principles he had declared, and made his own, and adopting those of the most opposite character, will necessitate my particularizing, with some apparent minuteness, though as concisely as possible, the principles and details of the scheme I have ventured to propose. When I state that the declaration of your Consulting Engineer, that "he considered the practice of the drainage of the refuse of towns to the natural outfalls, under any circumstances, *an erroneous proceeding*," first suggested to me the desire to place before you my views on the subject, in contradistinction to such declaration,—a declaration, propounding a principle at issue with every element of economy,—you will concede to me, I trust, the opportunity of rendering

as prominent as possible, the means by which I propose to render the *natural* outfalls available in every way it is possible to do so, and the means, by which I would thus reduce to a minimum, the application of mechanical power, and the present cost and future maintenance of the drainage works. I propose to separate the Metropolis into two main and characteristic divisions, one discharging its sewage by natural agency at high-water level, and the other discharging its sewage by mechanical agency a little below low-water line; to retain the present system of sewers (amended and altered as may be required), as subservient to this prescribed division; to supply an ample quantity of water to cleanse the sewers, regulating the quantity supplied agreeably to the fall and size of each sewer; and to limit the agency of mechanical power to the low lying districts, and to a force and service, simply sufficient to render the present low-water line a *constant line of outlet* for those districts, without seeking to do more.

Under the following heads the necessary works are described; but I claim reservation for amendment, and alteration in subordinate details, as further information is supplied.

First. To provide a pure, abundant and constant supply of water, to be substituted for the impure, scanty, and intermittent supply, now furnished by the Chelsea, West Middlesex, Grand Junction, Southwark, Lambeth, and Vauxhall Water Companies; to use their present supply for the purposes of sewerage only; and to consolidate the whole under the jurisdiction and future management of the Sewers Commission.

Second. Taking a mean height of twelve feet above Trinity high-water datum, as a line dividing the higher from the lower portions of the Metropolis, to sub-divide the former into districts, each discharging by the simple and natural force of gravitation, its liquid refuse by intercepting drains, at heights sufficient to command constant, perfect, and unobjectionable outfalls, and at points where the prospect is immediate, and the circumstances favourable for the use of the sewage to the purposes of agriculture and horticulture; and to construct reservoirs and filtering-beds at the depôts in connection with such intercepting drains, for the purpose of extracting and retaining for sale the fertilizing matters in a consolidated form, when irrigation is less profitable.

Third. To convey by two low level main drains, with several intercepting branch drains communicating therewith, the whole of the sewage of the lower portions of the Metropolis to two depôts, one in Plumstead Marsh, on the south of the Thames, and the other at Barking Creek, on the north, there to be raised by steam power for irrigation, or immediate discharge, or delivered into reservoirs and filtering-beds for consolidation and sale.

Fourth. To extend the proposed operations to the low meadows and marsh lands extending along each side of the Lea, and along the Thames from Bow Creek on the one side, and Greenwich on the other, as far as the limits of the City conservancy, with a view to effect a systematic drainage of the several tracts, or levels, of which they are composed. The soil of these large tracts, abounding in the elements of fertility, would immediately become available as market garden-ground, and in that character would afford a wide space for irrigation, and the application of the sewage manure. Moreover, by including these works and wide reaching lands within the intended operations and jurisdiction of the Commission, a continuous and permanent outlet to the sea may be secured and for ever maintained on each side of the river, independent of its tidal action, with all the advantage of intermediate outlets at differences of time, afforded by the ebb of the tide down the river, for a distance of more than forty miles.

1st. *Water Supply*.—It is proposed to unite by an open or covered channel, the surplus water of the Thames, (*i. e.* as much as may be attainable, after a due provision for navigation), with the water of the Colne, a little above Colnbrook, and, by the course of that branch of the Colne, called the Queen's River, convey it to *Feltham*, at a point where the latter crosses the "Windsor, Staines, and South Western Railway," at the summit of that line.

The point from which it is proposed to take the water from the Thames, is a little above *Boulter's Lock*, the height of which is about *sixty-seven feet above Trinity datum*, and *twelve feet above the level of the water in the Queen's River*, at the point where the "Windsor, Staines, and South Western Railway" crosses it. Reservoirs here constructed, adjacent to the Railway, would receive and collect a supply amply sufficient for the districts served by the before mentioned Companies, for at least *nine months* in the year, without infringing upon the quantity necessary for the river navigation.

To secure a command of the Colne for the remaining *three months*, so as to render its waters available when those of the Thames are denied, it would be necessary to purchase the comparatively few mills intervening between Colnbrook, and its junction with the Thames, or to compensate the owners for the loss of water which might possibly occur during those three months. A very large quantity of water might be conserved in the reservoirs in time of plenty, to furnish a supply independent of both rivers in the time of drought. From these three resources, the *Thames*, the *Colne*, and *conserving reservoirs*, an ample supply of pure water would be at disposal, at a minimum height of fifty feet above Trinity high water datum. From *Feltham*, the water would be economically conveyed by pipes laid within the property of the South Western Railway Company, to such points as it would be most convenient for diverting into courses of supply, or for raising to a higher level for high service. *Feltham* is fifteen miles distant from the Waterloo-bridge

station of the South Western Railway, and six and a quarter miles from the Kew-bridge station, on the Loop Line of the same railway, and there exists a fall, broken only by intermediate undulations of insignificant magnitude, between the proposed reservoirs at Feltham, and the ground surface in Kennington and Lambeth, of fifty-five feet; and a similar fall of fifty feet between Feltham and Strand-green, near the Kew-bridge station. Thus it will be seen *that facilities exist for supplying with water, by the simple and costless action of gravity*, all those low, wide, and thickly populated portions of the Metropolis, embracing Hammersmith, Chelsea, and South Westminster, and that part of the Metropolis lying south of the river, and now so *inadequately* supplied with *impure* water. At Strand-green the water would be diverted from the railway, and following the course of one of the principal low level drains, would be brought into the heart of these districts, and from thence distributed, by means of the present and additional water mains and pipes, to the inhabitants, at a height approximating thirty-five feet above the surface; which is practically efficient for every domestic purpose, and all that can be required for sewerage purposes, should the appropriation of the present water companies' supplies to that object not be carried out. One or more mains might also be laid along the South Western Railway, by Nine Elms and Vauxhall, to divide with this conduit the supply to the districts now served by the Lambeth, Southwark, and South London Companies, close to whose works the railway passes, and into whose reservoirs the pure water from Feltham might be at once discharged, in lieu of the tidal water, which now undergoes filtration. For *high service*, it is proposed to construct a small reservoir near the Richmond Railway (near Putney for instance), to receive, by the flow of gravity, the water from Feltham, at a height as nearly the same as the Feltham reservoirs as the loss by friction in the pipes by which it is conveyed will permit, and from thence to raise it by steam power into reservoirs in Richmond-park, or rather *Wimbledon Common, about 180 feet above Trinity high-water datum*.

Another and distinct source of supply for high service presents itself, as identified with this neighbourhood.

Near the junction of the South Western Railway, with its Richmond branch, water may be tapped and brought to the surface by its own hydraulic pressure, which being collected, may be pumped up into the same reservoir, and thus the cheapest form of artesian well may be made available to furnish some portion of the supply when drought may have reduced the quantity from the Thames and Colne. The water thus raised and collected at a height of 180 feet above high-water, may be delivered to the top of every house in the highest portions of the Grand Junction and West Middlesex Districts. It is proposed to continue to the districts now supplied by the New River and East London Water Companies, the same sources of supply for both domestic and public purposes; but with respect to those companies already enumerated (which furnish the water of the Thames), it is suggested

that their supplies should be devoted to sanitary purposes only, and that the whole be placed under the jurisdiction of your Honourable Court.

2nd. High Level Drainage.—With respect to the *high level drainage*, it is proposed to subdivide into districts the whole of those portions which are on a higher level than twelve feet above Trinity datum, governed by the inclinations and undulations of the surface towards the Thames, and the falls of those several streams which were formerly its tributaries, and which now receive for the most part the drainage of the ground on each side of them. Taking the northern portion of the Metropolis, we find the general inclination of the surface to be towards the south-east, and that the course of the Fleet River (now Fleet Sewer) following the same direction, cuts the high-land portion nearly in half. It is proposed to adopt this natural line in dividing the high level drainage; and by means of two main outfall drains on each side thereof, provide a discharge for the whole above high-water level; one side to flow *westward*, and the other *eastward*.

It is possible that the proposal to carry a portion of the sewage by any other course than the most direct fall of the surface, may be deemed at variance with the principles here set forth. To a certain extent this is admitted, and care has been taken to secure, by the course laid down, an effective fall and *ultimate* discharge. Under any circumstances it would be easily practicable, by lessening the area of high level drainage,—by adopting a more circuitous route (the proposed Holborn viaduct would afford a favourable mode of crossing the Fleet estuary, at a higher level than the ground surface), and increasing the size of the conduit *to direct the fall eastward*, and carry the sewage of the western in conjunction with the eastern side, to the point of discharge at Barking Creek. But in dealing with the question of outfall, it is essentially requisite that we should not only provide for an effective discharge, but that we should consider an object which, though inferior in importance, is still of vast magnitude,—that of turning to profit the sewage we are designing to eject. It is with some diffidence that I venture here to express an opinion that has influenced me in designing the course of the outfall drains. Much has been said on the value of liquid manure for irrigation; and the extraordinary yield from certain meadow grounds thus treated, has been adduced as a reason why we should look to such an application as a means of securing to the rate-payers of the Metropolis some return for the costs of the proposed improved drainage. London is surrounded for more than three parts of its circumference with grass land, and if those arguments were to prevail, there exists a wide scope for this mode of applying the sewage. But experience daily shows, that to produce a profitable effect upon grass land, the liquid refuse must be applied in a state so highly charged with feculent matter, that the pumps applying it would be liable to become choked; or, if that difficulty be overcome, that the atmosphere around the irrigated grounds would become so impregnated with injurious exhalations, that the anticipated benefit

would become a positive evil. The reason of this is obvious: the close matted nature of the roots and the herbage of grass, resist the downward action of the feculent liquid into the soil, and exhalations proceed more rapidly than the absorbent action of the soil. Not so with garden ground, which being constantly stirred, and rendered open and porous in its texture, is capable of immediately receiving and retaining all the fertilizing matter, of which water may be the vehicle for conveying to it. Moreover, irrigation, as a mode of watering garden ground, is in itself a highly profitable process. For these reasons it is proposed to direct the sewage of one considerable portion of the Metropolis towards those suburban parishes, where market gardens are most numerous, and where the London Sewage Manure Company have already raised an establishment for the distribution of the liquid. And for the same reasons, the drainage of the meadows of the Lea, and the marsh lands of the Thames, is urged as a part of the general scheme, in order that the operations may lead to the more profitable cultivation of those large flats of meadow and marsh, as market garden ground. Commencing, then, with the higher level division, *west of the Fleet sewer*, it is proposed to make two intercepting drains, an "upper drain" and a "lower drain," to meet and discharge at a depôt, situate between the present Counter's Creek sewer, and the West London Railway.

The upper drain of this division, commencing at the depôt, would run north of Holland-park, by Westbourne-grove, New Church-street, Alpha-road, and the outer circle of the Regent's-park, to Barrow-hill, where it would join the upper end of the King's Scholar-pond Sewer, not far from the Reservoir of the West Middlesex Water Company.

The lower drain, commencing at the same spot, would pass to the south of Holland-park, along Kensington High-street, within Hyde Park, along Piccadilly and the upper part of the Haymarket, by the line of streets north of, and nearly parallel with, the Strand, by Clare-market and Lincoln's-inn to Holborn-hill, where it would intercept and receive the sewage now flowing to the Fleet. In the passage of this drain from Holborn to the outfall depôt, it would cross the several main sewers of the Westminster division, and would intercept their sewage. The site of the depôt for this district to which both these drains converge, is selected in consideration of the following points, viz., its proximity to the numerous market gardens of Chiswick, Brompton, Kensington, Chelsea, Ealing, Brentford, and Isleworth, and the two-fold use of the Counter's Creek-sewer as an existing means of communicating with the Sewage Manure Company's works at Stanley-bridge, and as an outlet whereby to discharge the liquid refuse brought to the depôt, into the Westminster Low Level-drain, (hereafter described) at the point of crossing near the dock of the Kensington-canal; but the necessity of using it in the latter capacity, would only arise should the demand for irrigation and manufactured sewage manure cease to exist. The West London Railway would afford facilities for the transmission

of the manufactured manure into the country. The height of the ground selected for the *depôt* will also admit of the application of the filtered and valueless liquid after the fertilizing matter has been extracted from it for the purposes of flushing such intermediate sewers as lie between the *depôt* and the Westminster Low Level outlet-drain. For the district *east of the Fleet*, the upper drain, commencing at a *depôt* it is proposed to establish at Barking Creek, would pass for a considerable distance through the marshes and the eastern low level district, for which distance it would act as a discharging conduit to a *depôt* it is proposed to establish north of Victoria-park, for the purpose of receiving and distributing the sewage of the upper part of the division either for irrigating the lands in the valley of the Lea, or disposal in a manufactured state. From this *depôt*, the course of the drain would be by the Hackney-road, and a line of street in continuation thereof to the Eagle; thence crossing the City-road to Nelson-street by another line of streets to and across Wilmington-square, on the south-west of the New River-head, thence by the north angle of the House of Correction over the Fleet Sewer to Gray's Inn-lane, the course of which it would take to King's-cross, when it would follow the course of the Fleet Sewer, and intercept its sewage near the Old St. Pancras Church; the course of that sewer would then be adopted up to St. Pancras Workhouse, from whence it would take a north-west direction to the foot of Primrose-hill. The lower drain, commencing at the same spot, would in like manner as the upper drain, pass through the marshes and the eastern low level district to the Commercial-road, Limehouse; from whence it would diverge through Brook-street, Back-street, Cable-street, and Rosemary-street to the Mint; thence by the Tower-moat, to and along Great Tower-street, East Cheap, Cannon-street and Watling-street, to the south of St. Paul's; thence by Ludgate-hill, Old Bailey, Giltspur-street, to and across Smithfield, where it would join the John-street sewer.

The site of the *depôt* to which both these drains converge, is selected in consideration of its proximity to the river, at a point for discharge sufficiently distant to preserve the Metropolis from the deleterious effect of the returning action of the tide; eligible for the distribution or the manufacture and sale of the sewage, and available as a discharging point for the Eastern Low Level Drain. These outfall drains dispose of the higher districts north of the Thames. Intercepting drains, carried along the hill sides in like manner, dispose of the sewage of the higher lands lying on the south of the Thames.

3rd. Low Level Drainage.—The whole of the low lands of the Metropolis, lying at a level less than twelve feet above Trinity datum, may be divided into three levels or districts, viz., 1st. The Westminster Low Level District, comprising all that river side division bounded for the most part by the Western-road, and Piccadilly on the north, and by the river on the remaining sides, but extending in an irregular course up the Fleet-valley on the east, and up the several vales towards Starch-green

and Acton on the west; 2ndly. The Southern Low Level District, comprising the low and populated portions of the Surrey and Kent division of sewers; and, 3rdly, The Eastern Low Level District, taking in all the low lands of the Tower Hamlets division, including the Bromley and Poplar Marshes and the Isle of Dogs. It is proposed to provide one outlet drain for the *two* first-mentioned districts, to discharge itself at a *dépôt* in Plumstead Marsh, nearly opposite Barking Creek. Steam power would be applied to raise the sewage above the rise of the tide, so as to secure a constant discharge into the river. The course of this outlet drain would be through the towns of Woolwich, Greenwich, and Deptford, where it would pass near the proposed *dépôt* for the southern higher districts, to which it would act as an outlet of discharge; thence along the Greenwich Railway, to and along the Blue Anchor-road; thence, in a nearly direct course, by the Bricklayer's Arms, the New Kent-road, near Bethlehem Hospital, and Lambeth-road, to and across the river by curved iron tubing, or *inverted syphon*, to the Horse Ferry-road; thence along the proposed new street south of the New Prison, and by various streets and openings to, and diagonally across, Eaton-square; thence, by a nearly direct course, through Earl's-court to King's-street, Hammersmith; thence along the high road and the south side of Turnham-green to Strand-green, near Kew-bridge, at which spot it would meet the water supply from Feltham, before described. Several branch drains will be necessary to catch the sewage not provided with outfall by the higher level outfall drains. One of considerable importance, commencing at the outlet drain at Horse Ferry-road, would pass along the river side to Blackfriars'-bridge, to receive the lower sewage of the Fleet Sewer, and of the various sewers discharging into the Thames between those two points. This branch would join the outlet sewer at so low a level as to admit of its being constructed or laid beneath the shore of the river; and thus it would in no way interfere with existing river bank property. Other branches of importance are described in the paper already delivered, and are shown in the maps accompanying it. It is not necessary to particularise them here; but it must be understood, that an alteration or modification, and, in some cases, re-construction of the present main sewers lying intermediate between the proposed outlet drain and the river, would be necessary in order to convert the fall now directed to the river towards the outlet drain. But as these present main sewers are of a size more than sufficient to carry off the sewerage of the whole low level district which the proposed outlet drain would divide, it is apparent that smaller and sufficient sewers might be constructed altogether within the present sewers, so as to avoid disturbing, if possible, the street traffic, and at considerably less cost than entirely new constructions; for it should be borne in mind that these sewers have been found sufficiently capacious to hold the surface drainage, which, as already stated, it is now proposed to pass at once into the river by shallow street-drains. The length of the proposed Westminster Low Level drain would be seventeen miles, with a fall of two feet per mile for seven miles of the upper portion, viz.,—from Strand-green to Horseferry-road,—and one foot and a half per mile from thence to the *dépôt* on

Plumstead Marsh. The depth at the mouth, or point of discharge, at Plumstead depôt would be thirty-four feet below the surface; and at the head of the drain at Strand-green, seventeen feet below the surface. The invert of the drain at the dip of the *inverted syphon* by which the drain would be carried under the river at Horseferry-road, would be twenty-one feet below Trinity high water datum.

It is proposed to furnish this important drain with a constant current of water, for the supply of which several sources present themselves, and have already been alluded to. In the first place, there would be the discharged fluid (from which the fertilising matter had been extracted) from the western high level sewage, the supplies of present water companies, and tidal water obtained from the Thames at high tides at points of proximity.

For the eastern low level district it is proposed to provide an outlet by a drain commencing at the Barking Creek depôt, running across the Ham and Plaistow Marshes, to and under the river Lea, at the iron bridge, thence it follows the same (but a deeper) course, as the eastern high level outfall drain (as shown by the map) to the Commercial-road, Limehouse, and from which course it proceeds along Upper Shadwell, Ratcliffe Highway, East Smithfield, to the Tower, and round the Moat to Great Tower-hill, and through Lower and Upper Thames-street, to St. Andrew's-hill.

In the course of this drain, the various sewers now falling into the Thames would be intercepted, and ample facilities would be given for the future drainage of the marsh districts not yet built upon.

A difficulty presents itself of securing an outfall, independent of the river, to the sewers of those clusters of buildings which have become isolated by the London and St. Katharine's Docks, but a means suggests itself in the Thames Tunnel, through which (below the carriage-way) a drain might be carried, communicating with a branch of the Westminster low level drain, on the south side of the Thames. The length of the eastern low level outlet drain would be $8\frac{1}{4}$ miles; the fall would be two feet per mile; its depth at the mouth, or point of discharge at Barking Creek depôt, would be thirty feet below the surface, and at the head of the drain twenty-six feet below the surface. The greatest depth of excavation would be thirty feet for a short distance. The sewage issuing from this drain would be raised by steam power, assisted by such natural force as might be acquired by the descent of the fluid refuse issuing from the outfall drains of the eastern high level district, which it has been before described as intended to be brought to the same depôt as a point of discharge.

4th. Thames Marsh Improvement.—For the improvement of the marshes on each side of the Thames, and the provision of an effective and constant outfall for the surplus water now stagnating in the low meadow grounds on each side of the

Lea, and rendering their cultivation as grass land a permanent and obligatory proceeding, tidal mills might be established at various points of discharge along the river banks, to be employed in raising the water now retained in the soil; and the tidal water, conserved at its highest level, will supply a vehicle for sewage irrigation only to be appreciated after the lands are drained; but the application of steam power has been attended with such effect and economy in the fens of Cambridgeshire and Lincolnshire, that there can exist no doubt as to the capability and profit of draining lands of such description, nor the value of steam as a mechanical power where natural force is beyond reach. It is, therefore, suggested in the present instance as an alternative for application at points where tidal mills would be less profitably effective.

(Signed)

J. BAILEY DENTON.

9, Gray's-inn-square, Oct. 12, 1849.

FREDERICK DRAYSON, Esq.

Report on the Drainage of the Metropolis, to be appended to Mr. COXWORTHY'S Memorandum of the 15th of August, 1849, on the principles of which it is based.

To the Honourable the Metropolitan Commissioners of Sewers.

FROM an examination of the best maps, it appears that the area of the district which is understood to be included in Mr. Phillips's report, and for the drainage of which plans are required, is about 170 square miles; of which about forty square miles are covered by houses and other buildings, streets, roads, lanes, courts, and alleys, leaving about 130 square miles of fields and garden-grounds.

It must be obvious, that in dealing with a question of such vast magnitude as the drainage of this large district, on which stand upwards of 300,000 houses, inhabited by more than 2,000,000 of human beings, besides innumerable manufactories of every kind, vast gas-works, breweries, and distilleries, unparalleled in extent; immense stables and cow-houses, occupied by tens of thousands of animals, all daily generating great quantities of most offensive matter, to which is to be added the dung of upwards of 200,000 beasts, 1,500,000 sheep, as well as calves and pigs, annually brought into London, and the refuse from their carcasses after slaughtering, with other causes of filth too numerous to mention, that difficulties of no ordinary kind present themselves; the more especially, as it must be borne in mind, that London is increasing daily in size and population; that what in other places would be considered large cities, are springing up annually in all directions in its environs, the houses being no sooner built than inhabited; and therefore, any system of drainage, which may be limited in its operations, would be totally inapplicable to the Metropolis.

It may not be out of place to refer to what has been the increase in the population of London since 1801 ; and it is found that at that period, namely—

1801, it amounted to	858,000		
1811, „	1,011,000.	being an increase of	153,000
1821, „	1,225,000	„ „	214,000
1831, „	1,471,000	„ „	246,000
1841, „	1,873,000	„ „	402,000

and therefore it may be fairly estimated, that in 1861 the population of the district to be drained will approximate to 3,000,000.

And on reference to reports on the supply of water by the various water Companies, it appears that in

	Cubic Feet.		Cubic Feet.
1828, it amounted to	4,587,840	per day, or	53½ per second.
1833, „	6,566,400	„	76 „
And at the present time it is about	10,000,000	„	115 „

Thus clearly showing that the supply has increased in a greater ratio than the population ; and as at the present time, there are 70,000 houses unsupplied by any water company, increased habits of cleanliness are obtaining amongst the lower orders, and the use of water-closets is daily becoming more common, in fact is considered an indispensable adjunct to sanitary reform ; it is evident that the future increase in the use of water, and consequently the increase of sewage, must necessarily greatly exceed the future increase in the population, and at no distant period will be double what it is at present.

Were the disposal of the water supplied by the various companies alone concerned, the question would be relieved of much of its difficulty ; but London, like every other part of the kingdom, is liable to be visited by sudden and heavy falls of rain. On an average of years, it appears that the total depth of rain which falls in London, is about two feet per annum ; but on several occasions, as much as an inch of rain has been known to fall in three hours ; and therefore, although the total fall per annum upon the 170 square miles is only 9,478,656,000 cubic feet ; and upon the 40 square miles, at present covered by houses, &c., is only 2,230,270,000 cubic feet ; yet, the quantity of water that would descend during a heavy shower, like those above referred to, would be as much as 394,944,000 cubic feet on the 170 square miles, or 92,928,000 cubic feet on the 40 square miles.

Now, there is no difficulty in intercepting the land drainage of the 130 square miles, and conveying it into the Thames and its tributaries, by waste-water channels, separate from the sewers containing the sewage, many of which nature has provided already ; and it is proposed to do so ; therefore, we have to provide for the discharge of the rain which falls upon the 40 square miles only, in addition to the house

drainage; but the increase of the population will progressively cover the now open land with buildings, and change the present land drainage into sewerage, adding thereby to the quantity of sewage to be discharged through the sewers, and diminishing the quantity to be got rid of as land drainage.

Advantage having been taken of the extension of time granted by the Commissioners of Sewers for delivery of the plans, in giving a careful reconsideration to the principles already adverted to, on which to base an efficient system of drainage for the Metropolis, in order to determine whether artificial means could be resorted to, in contending with the foregoing facts; it has resulted in adding further testimony in support of the conviction previously entertained, that all such appliances must prove utterly abortive in dealing with such masses of matter; and therefore, the following observations are based on the principles already explained in the papers sent to the Commissioners on the 15th August last.

It will be seen, on reference to the levels marked on the plan furnished by the Metropolitan Commissioners of Sewers, that the Metropolis, as regards drainage, is naturally divided into several districts, which offer abundant facilities for an efficient and complete drainage into the Rivers Lea and Thames from the north, and into the Thames from the south.

THE NORTHERN DIVISION.

EASTERN DISTRICT.

This large and populous district extends from the River Lea on the east, to Highgate, from thence in a southerly direction, past Copenhagen House Tavern, and the New Model Prison, to Claremont-square; thence to Aldersgate-street, and past the east end of St. Paul's Cathedral to the Thames, which forms its southern boundary; from thence to the mouth of the Lea, at Blackwall.

Subject, in a measure to the existing sewerage, which is not shown on the map supplied, it is proposed, for obvious reasons, to divert, as far as practicable, the drainage of the whole of this district towards the valley of the Lea.

WESTERN DISTRICT.

This, the least populous district, includes the western part of the Metropolis, and extends to Hampstead, on the north-east, and from thence, in a southerly direction, through Portland Town, St. John's-wood, and Westminster, to the Thames.

Subject also, in a measure, to the existing sewerage, which, as before stated, is not shown on the map supplied, it is proposed to divert, as far as practicable, the drainage of the whole of the district to the west, towards Hammersmith.

THE CENTRAL DISTRICT

Will comprise the whole space between the foregoing two districts, the natural drainage of which is principally down the valley of the Fleet ditch, and through the Northumberland and other sewers, into the Thames.

The villages lying east of the Lea would be drained towards that river, and those west of Hammersmith towards the Thames.

THE SOUTHERN DIVISION.

The whole of this portion of the Metropolis is admirably situated for drainage, which may be conveyed in almost any direction, and it is proposed to drain the whole of it into the Thames; Deptford, Greenwich, and the villages south of those places being drained both into the Thames and Ravensbourne.

GENERAL REMARKS.

It may be observed, in reference to the drainage to the east, that, in the valley of the Lea, the sewers will pass through large tracts of fields and garden-grounds, in which some of the existing sewers may be left open until they become objectionable, and they offer every facility for the collection between dams of the sewage matter, and its ready disposal on the spot; a remark that equally applies to the western district.

For the central district the construction of dams in the sewers will be necessary, agreeably to the plans already described in the letter to the Commissioners of 15th August last, the flat lands of Westminster affording ample facilities for collection and removal of the soil; and, in respect to the more central portion of the metropolis, the lines of streets from Blackfriars'-bridge eastward and westward, may be made available for the same purpose.

In the construction of the discharging sewers, it is proposed to provide sufficient space in them for the slow flow through them of the water of house drainage and ordinary rains, it being conceived that, to provide sewers sufficiently capacious to effect the same object during heavy falls of rain, would entail an expense which the object to be gained would not justify; more especially as the sewage matter, having undergone putrefaction in the sewer, would no longer be offensive, and would therefore only add a little to the matter or debris which, on all such occasions, is washed down into the river from the country.

With reference to the southern side of the Thames, many of the collecting sewers will pass through fields and garden-grounds, and may therefore be left open, and the remainder, being mostly in flat localities, will be subject to the same arrange-

ment as those on the northern side of the river, the filth in both cases having to be removed in barges.

In regard to the drainage of the villages more remote from the Thames, it is proposed, after the solid matter held in suspension in the sewage shall be deposited in the sewer, to allow the pure water to make its escape into the Thames or its tributaries, through the waste water channels; and, as respects those localities which are not shown on the map supplied by the Commissioners, and consequently no levels given, it may be remarked that most of them are not of great importance, the most populous, Woolwich, is known to be well situated for drainage, although the course in which it is proposed to direct it is not here shown, no levels having been afforded to enable it to be stated with accuracy.

No detailed estimate is given of the cost of carrying out the foregoing plan, since the information most required as regards the levels of the surface is not given, and no information whatever has been afforded in reference to the existing sewers and their levels. To what extent they might be made available, with or without alteration, in carrying out the system here recommended cannot, therefore, be determined with any degree of accuracy; but assuming that the existing sewers have been constructed with due regard to the natural slope of the surface, the expense of carrying out this plan would not, upon a rough calculation, exceed £150,000.

Having thus described what appears to be the only practicable plan for the efficient drainage of London, it may be observed, in reference to the principles on which it is based, that the power of water to convey matter specifically heavier than itself depends upon the velocity at which it moves; therefore, the lighter the matter held in suspension, the more slowly the water should flow to enable a deposition to be effected; and to show how rapidly the matter held in suspension in the London sewage is deposited under these circumstances, it may be stated that, when on an inspection of the eastern district, it was ascertained from Mr. Eady, the Principal of Wick Hall Collegiate School at Hackney, that the ditches in his grounds, which are connected with the Hackney Brook Sewer, were always refilled in a few days after cleaning out, by the deposition of the matter held in suspension in the sewage, brought down in that sewer when dammed back by the tide, which operates for only a short period at each time of high water.

Numerous other instances might be adduced that sewage matter does rapidly deposit in water flowing slowly, and that the water becomes mechanically pure in the course of a very short distance under this operation; and, as the heavier portions of the sewage matter would be deposited in the upper parts of the discharging sewers, and the lighter portions nearer to their mouths, it would be only in these latter parts of the sewer that a deodorising material would, under any circumstances, be neces-

sary; and thus each kind of matter deposited would be readily available for application to the purposes to which it would be suited.

(Signed)

FREDERICK DRAYSON.

4, Great Queen-street, Westminster,

16th October, 1849.

MESSRS. DREDGE AND STEPHENSON.

THE main features of this plan are comprised under the following heads:—

I.—THE NORTH SIDE OF THE RIVER.

a. The laying down of a stone glazed intercepting sewer, as shown in red on the plan, from Brentford and Fulham, discharging the sewage into a well at Stanley-bridge, where it is to be lifted eighteen feet.

b. The construction of a cast-iron intercepting sewer, from the last named well at Stanley-bridge, at which point it is on a level with high-water mark, to a well, to be situated at the outlet of the King's Scholar's-pond sewer. The course of this sewer will be along the Cheyne-walk to Cheyne-row, from thence to the well at King's Scholar's-pond sewer, it follows the river line, being sunk along the whole distance beneath the surface of the shore, with the exception of the portion between Cheyne-row and Chelsea Hospital. Along this portion for a distance of 400 feet, it is proposed to build out the river wall three feet, and carry the sewer behind it, so as not to interfere with the present wharfage property. The sewage at this second well is to be lifted sixteen feet.

c. The continuation of the last named outfall sewer from King's Scholars-pond well to Blackfriars'-bridge. The course of this will be along the Millbank-road, taking the river line at the end of Milbank-street, and following that line to Blackfriars'-bridge. The only part of this section in which the sewer would be above the shore, and consequently interfere with the wharfs, is that between Milbank-street and Westminster-bridge; and along this portion, by building out the river wall, and carrying the sewer behind it, we shall obviate this difficulty.

d. The level of the outfall sewer at Blackfriars'-bridge, is twenty-two feet below high-water mark. It is proposed to construct a brick tunnel, * diameter from thence to the intended final reservoir in the Plaistow Marshes (passing under the Mint, High-street Poplar, and the River Lea), where the sewage will be pumped up thirty-five feet into reservoirs for distribution and sale. The present surface sewers are to be concentrated, and the sewage let into the tunnel by two or more vertical shafts.

* Blank left in the original MS.

The great objections that have been urged against the construction of an intercepting river pipe are,—

- 1st. The difficulty of obtaining sufficient fall.
- 2nd. The interference with wharfage property.
- 3rd. The passing by the Docks.

It will be seen by the foregoing, that by our plan these difficulties are obviated, a combined, artificial, and natural fall being obtained by dividing the pipe into sections, and having three engine stations, by means of which we have a fall of five and a half feet per mile in the first, seven feet per mile in the second, seven and a half feet per mile in the third, four and a half feet per mile in the fourth section. This is considered the grand feature in the plan.

It will also be seen that we do not injure the wharfage property, or interfere with the dock entrances. It is proposed to make the communications between the present sewers, and the main sewers, as shown in the drawing, No. 1A. The estimated cost for the construction of all the above proposed works is £132,000.

II.—THE SOUTH SIDE OF THE RIVER.

It is proposed to drain this district by running a main outfall sewer along the line of the Grand Surrey Canal, and having one engine station near Cold-blow Farm, where the sewage water will be pumped over the surrounding country, or pumped through a pipe into the river below Greenwich Marshes.

The drainage of Greenwich, Deptford, and Rotherhithe, is to converge westward to this point, so as to employ as little engine power as possible.

III.—THE SEPARATION OF THE SEWAGE FROM THE SURFACE WATERS,

By placing where practicable, within the large sewer a smaller tubular pipe, (the size of which is regulated by the quantity it will receive), to intercept the sewage, and separate it from the land waters, thereby rendering it fit for agricultural purposes; and where not practicable, constructing a new pipe for this purpose, and appropriating the old one entirely for surface drainage.

(Signed)

DREDGE & STEPHENSON,
Civil Engineers.

10, Norfolk-street, Strand.
12th October, 1849.

MATTHIAS DUNN, Esq.

To the Commissioners of the Metropolitan Sewers.

IN venturing to submit my views upon this most important subject, I may premise that the existing evils, as communicated to the Commissioners on the 23rd July last, are as follow:—

1.—Inadequacy of a supply of water sufficient to cleanse and wash away the filth of the sewers during the prevalence of dry weather.

2.—The irregularity of the main sewers, and the want of communication between them and the house drains and cesspools. I may also add, the comparative lowness of the levels as regards the river Thames.

3.—The unventilated state of the sewers, which, in consequence, send out the most noisome effluvia from their openings and gratings.

I commence my observations with the conviction that *no single scheme* can possibly embrace the various circumstances under which this immense city and its suburbs are situated; but it must consist of a variety of arrangements, each one being suited to a certain given area, the details of which cannot, in my opinion, be embraced by any body of functionaries. I, therefore, confine my view of the case to *general principles*, under the two following heads, viz.:—

1.—Those parts which are sufficiently above the level of the Thames to enable them to be brought under the operation of cleansing by the application of abundant supplies of water.

2.—Those parts which are so nearly upon a level with the Thames as to render the above method less effective.

1.—The elevated parts of the Metropolis:—

Upon examination of the plan and borings, I think I may safely infer that the London clay exists to a much greater depth than the level of the river Thames, which would render the expense of tunnelling quite ordinary in facility and cost. I will, therefore, elucidate my principle by the accompanying profile, and by assuming a position to be taken in the vicinity of the Charter-House, which is distant from the river Thames about three-quarters of a mile, and where the level is represented to be about 60 feet above high water. Here I propose to sink a shaft, B, to the depth of low water mark, with which I would connect a tunnel, C C, of 4-feet diameter, for the purpose of bringing thither an unlimited supply of water.

Upon the top of this shaft I would erect a powerful engine, D, with one or more pumps of 30 inches diameter, the produce of which might occasionally be sent along the streets; but when put into the sewers, E E, I would cause the current to be directed from point to point at discretion, by means of plank doors.

For the double purpose of the engine boilers and for ventilation, I would erect a tall spacious chimney, F; and I would feed the boiler fires with air taken from the sewers, the effect of which would be that the atmospheric air would rush in at the mouth and gratings of the sewers, and be discharged along with the smoke at the top of the chimney.

I may state, in round numbers, that an engine of 80-horses power, working a pair of 30-inch pumps, would produce from 5000 to 6000 gallons per minute, which, acting in one column, would create an enormous cleansing power upon every part of the district lying below the said level.

I leave it to others better acquainted with the affairs of the city to say, whether such a command of water would not be a great boon to the inhabitants if they were permitted to have it free from a public fountain, and whether it would not be a great safeguard in cases of fire, by passing it down the streets. The main sewers once established in a system of uniform cleanliness, it is imperative that the minor sewers, house drains, cesspools, &c., should be communicated therewith.

As to ventilation, it is clear that the most natural and most effective system would take place by means of the boiler-fires and the heated chimney.

With regard to damaging the water of the Thames, I am of opinion that this evil would be much lessened if by my system the contents of the sewers were regularly carried away, instead of being (as at present) permitted to accumulate for weeks or months till the fall of rain. To avoid passing the contents into the Thames is, in my opinion, *impossible*.

2.—Those parts which lie upon the same level as the Thames :—

To introduce a satisfactory system for cleansing districts so situated is, I admit, much more difficult; yet we are well aware that there are already sufficient outlets for carrying off the natural falls of water, and that during wet weather the nuisances are incomparably less than when they are allowed to accumulate during dry weather. I therefore still hold that the principle of *an abundant supply of water raised at the most elevated points*, although only run along the streets and surface sewers, would afford a great relief, especially if cisterns were provided for the public gratis, wherefrom they could supply themselves abundantly with water for cleaning purposes. The advantages in cases of fire have been before adverted to.

Much has been said regarding the saving of the manure ; and although it may be possible partially to effect such an object in some of the suburban districts, in my opinion it is totally impracticable in the populated parts of the Metropolis. Besides, the contents of the sewers would perpetually vary in proportion to the quantity of water sent into them, either by natural or artificial means. In fine, I do not think it is worth a consideration ; and instead of regretting the adulteration of the Thames, I think it may be matter of congratulation that so useful an outlet for the filth of the city exists.

CONCLUSION.

I again repeat my conviction, *that no one system of giant drainage can be made applicable to the cleansing of the Metropolis, independent of the practical objections which belong to the discarding of the present sewerage, the cost, and the interminable period required to complete any such schemes as those which have been proposed.* I therefore simply *claim the merit of suggesting a cheap, simple, and practicable plan of washing away the filth from the streets*, and of rendering the sewers wholesome and cleanly ; whilst I afford a continual supply of water to the inhabitants, and to the engines in cases of fire, at the lowest possible cost to the Metropolis.

(Signed)

MATTHIAS DUNN.
Mining Engineer.

Newcastle-on-Tyne, September 20, 1849.

CHARLES T. ELLERMAN, Esq.

There can be but one safe, salubrious, and economical mode for collecting the Metropolitan sewage and conveying it beyond the limits of the Capital ;—namely, by means of intercepting tunnels, or sewers. This idea is not novel. The plans submitted by Mr. John Martin, some few years back—those proposed by Mr. Phillips, Mr. Austin, Mr. Wicksted, and other talented men, are all, more or less, based on the same principle. Indeed, I see no other available means than intercepting the sewage by tunnels, and to be constructed under the present arterial or discharging sewers. By adopting this course, the Thames will cease to be the common sewer of London.

In 1845, Mr. G. Hawkins, Assistant Surveyor of the Westminster Sewers Commission, estimated, that the ordinary daily amount of sewage, discharged into the river would be as follows, for the Surrey and Westminster Sewers :—

Surrey Sewers	.	.	.	.	2,457,600 cubic feet.
Westminster	.	.	.	.	7,045,120 „ „
					<hr/> 9,502,720 cubic feet.

Brought forward	9,502,720 cubic feet.
To which I add, for the	
City and Finsbury Sewers, say about	3,500,000 „ „
Tower Hamlets	2,000,000 „ „
Daily amount	<u>15,002,720 cubic feet.</u>
Yearly Amount	<u>5,475,992,800 cubic feet.</u>
Reduced into tons	153,174,624 tons.
Add one-third for rain	51,058,208 „
	<u>gives tons 204,232,932</u>

When the views of the Commissioners shall have been fully carried out, it is to be presumed that the above amount will be increased by one fourth, say „ 51,058,233

Total Tons 255,391,165

Which will contain, solid and liquid exuvæ „ 488,735

Giving about one ton of human fertilizing matter in every 500 tons of sewage.

The selection of a plan from the list of competitors which will be submitted to your consideration, for arresting the pollution of the Thames, will have its object in finding a vent for the 255,000,000 tons sewage manure, which must no longer flow into the river. In order to affect this desideratum, as well as supply a liquid manure, which, if not equal in potency to the Manchester, will, at all events, nearly attain the reproductive power of the Edinburgh matter, I propose, by a very simple plan, to reduce the bulk by three-fourths, and consequently increase the fertilizing power of the Metropolitan sewage manure.

Thus, the 255,000,000 tons sewage matter will be reduced to 64,000,000 tons ; and the ingredients held in suspension and in solution, in lieu of being 1 in 700, in rainy weather, or 1 in 500 in dry seasons, will be reduced to 1 in 175 tons.

On referring to my plan, you will find that in lieu of adopting one vast tunnel, I advise the adoption of four tunnels, or intercepting sewer By having four termini, in lieu of three, two, or one, the circumambient country will derive the full benefit of the contents of the Metropolitan sewers, as well as of the adjacent villages. The outlay for these four will not be much more expensive than having only two tunnels, whereas four termini will not only give greater returns, but enable four or more counties to avail themselves of the London fertilizer.

By the concentration of the fluid in tanks, I propose to diminish the present amount of sewage from 204,232,932 tons to about 47,000,000 tons.

The Metropolitan Sewage Manure Company propose to vend their sewage manure at the rate of 3*d.* per ton, or £1 per acre, with an extra charge of 6*d.* per mile, giving an average of 8*d.* per ton. 47,000,000 tons being four times stronger than that supplied from Ranelagh and King's Scholar's-pond sewer, I should propose to vend at 8*d.* per ton, giving a gross return of £1,566,666; to this should be added a charge of 6*d.* per mile from the source of supply, and though difficult to estimate correctly, this amount will receive considerable augmentation, sufficient to cover labour for application by hose, the wear and tear of hose, &c. The above 47,000,000 tons will be applied, not in the ratio of 500 tons on meadow land, and 100 tons on arable land, as proposed by Mr. Smith, of Deanston, but at the rate of about 125 tons per acre on meadow, and 25 tons per acre on arable land, giving—

250,000 acres meadow at £4	3	4 per acre, or 8 <i>d.</i> per ton for 125 tons	£1,044,441
626,666 „ arable „	0	16 8 „ „ „	522,221

Total 876,666 acres

Total £1,566,662

and when the sewage system shall have attained the perfection aimed at, so that all the exuviae, both solid and fluid shall find its way into the sewers, I estimate that the grand total will amount to about 255,390,165 tons, which reduced by concentration to 63,848,000 tons, at 8*d.* per ton, will produce annually £2,128,301.

The perfect deodorisation of this enormous mass is of the most important consideration. Too many noxious gases are already evolving from refuse matter, from putrescent graveyards, and other disgraceful sources. It behoves us, whilst devising the means of purifying the Thames, and turning the sewage matter to account, to be mindful of the health of the public. The amount of sulphuretted hydrogen and ammonia* discharged into the Thames, and into the atmosphere, by the London gas works alone, is immense; we must, therefore, not increase the quantity by exposing the sewage manure in open tanks to the action of the atmosphere, thereby poisoning the neighbourhood of the termini, and unless some means be devised, the inhabitants of those localities where I propose to fix the termini will loudly protest against their establishment.

Now by very simple means this difficulty can easily be obviated.

By introducing sulphurous acid gas, by means of a leaden plunging-pipe and force pump, into the sump, both the sulphurous acid and the sulphuretted hydrogen will become decomposed into sulphur. As the sewage matter contains a large proportion of chloride of sodium, it will, in all probability be precipitated to the bottom of the sump. This operation is a very inexpensive one.

* About 20,000 tons of ammonia.

As soon as the tanks are filled, it will be found necessary to pour in a sufficient quantity of some deodorising substance, to rigidly guard against the possibility of effluvium; and, though many may claim preference and superiority in regard to their respective re-agents, no doubt can be entertained in the eyes of practical and scientific men, that some preparation of a fluid nature, will eventually bear the palm. The ammonia must be fixed, and the sulphuretted hydrogen rendered innocuous, a process, with sewage manure, utterly unattainable by peat or wood charcoal, or any dry preparation.

Considering the trouble, the expense, and the faint prospect of remuneration, I should on no account advocate the manufacture of poudrette from sewage matter, except at those periods when liquid manure cannot be made available. Profit, in this case, should not so much be looked to as preventing accumulation in the sewers, and keeping the men actively employed.

Having, to the best of my ability, pointed out the probable returns resulting from the sale of the concentrated liquid manure, and that of the poudrette, I now respectfully beg to call your attention to the accompanying Map of London and its environs.

INTERCEPTING SEWERS.

On referring to the map, plan A, you will find that I have divided the Metropolis into four districts. Each district to have an intercepting tunnel or sewer, with sumps and termini, namely,—

- No. 1, is the North Western, or Westminster District Tunnel.
- „ 2, is the North Eastern, or City, Finsbury, and Tower Hamlets Tunnel.
- „ 3, is the South Eastern, or Southwark, Deptford, and Greenwich Tunnel.
- „ 4, is the South Western, or Lambeth District Tunnel.

The North Western Tunnel, to commence at Essex-street, at sewer No. 1, taking Tweezer's-alley; Arundel, Norfolk, and Surrey-streets; Strand-lane; the Somerset Watergate, and stable yard sewers; Durham-yard, east and west; Fountain-court; Beaufort and Reeves' Wharf; Durham-yard; Saint's Wharf; York-buildings; Buckingham and Villiers-streets; Hungerford Market; Dirty-lane; Craven-street; Northumberland Main Sewer; Regent's-park Tunnel Sewer; Pall-mall Sewer; the drains from old Almonry office, and Whitehall-yard; Whitehall-yard Sewer; Bent's Wharf; Manchester-buildings; King's-street outlet, Westminster-bridge; Wood-street; College-street; Romney-row; the Grosvenor open sewer; King's Scholars' Pond Sewer, and collateral sewer, No. 32; New Ranelagh outlet, Smith-street, Chelsea; Paradise and Swan-walk; Queen-street; Manor-street; New-road, North; Cheyne-row; Lawrence-street; Church-street; Lombard-street; Danvers's-

street; Beaufort-row; Millman's-row; Riley-street, and passing under Couhter's Creek, terminate at a place called *The Town Meadows*, on the banks of the Thames, near Fulham.

The length of this intercepting sewer or tunnel, will be about $5\frac{1}{2}$ miles.

The daily average amount of London sewage discharged at this terminus, including rain, will be about 9,393,493 cubic feet, or 88,778,423 tons annually.

An ordinary sized branch sewer might convey the drainage and sewage of Chiswick, Hammersmith, and Fulham, into the sump or terminus at the Town Meadows.

My object in fixing upon this spot in the first instance, is to reduce the length of the intercepting sewer, thereby diminishing the outlay; secondly, to furnish the liquid manure to the numerous market gardeners residing in the vicinity, either in its diluted or concentrated state; thirdly, to facilitate the discharge of the clarified surplus water into the Thames, when the tide recedes.

The North Eastern Tunnel to commence at the Temple, intercepting all the sewers along Whitefriars, Blackfriars, and Thames-street; and passing under or near the Tower-moat, receive the contents of Irongate-stairs sewer; the Leith and Berwick Wharf sewers; the Union Stairs, Wapping, Shadwell, Ratcliffe, and Limehouse sewers; thence, passing below Bow Common, and the river Lea, terminate on the bank of that river, on the Essex side, near West Ham Abbey Marsh.

The length of this intercepting sewer will be about $5\frac{1}{2}$ miles. The daily average amount of London sewage discharged at this terminus, including rain, will be about 7,333,333 cubic feet, or 69,949,164 tons annually.

An ordinary sized sewer might convey the drainage and sewage of Bow and Stratford into the sump of the north-eastern terminus.

After subsidence, the surplus clarified water could be discharged into the river Lea.

The South Eastern Tunnel to commence near the Pudding Mill Sluice Sewer, (No. 8), at Blackfriars'-bridge, and in its course intercept the Boar's Head, the Black Lion, and the Bear Sluices; the Clink-street sewers, and those of the parishes of St. Olave, St. John, Bermondsey, and Rotherhithe, as far as the Thames Tunnel; here, running along the Deptford-road, through Deptford and Greenwich, receive the sewage of those localities, and terminate at the Greenwich Marshes. By means of

an ordinary sized branch sewer, the drainage of Woolwich could be discharged into the sump at the terminus.

The length of this tunnel will be about six miles.

The daily average amount of sewage, inclusive of that of Deptford, Greenwich, and Woolwich, discharged at this terminus, will amount to about 3,000,000 cubic feet, or 28,000,000 tons annually. The clarified water would be discharged into the Thames, between Bugsby's Reach and Woolwich Reach.

The South Western Tunnel to commence at Albion-street, intercepting this sewer, numbered 7; the Commercial-road sewer, No. 6; the Waterloo-bridge sewer, No. 5; the Westminster-bridge sewer, No. 4; the Lambeth Butts, Church-street, and Vauxhall-bridge sewers; thence, running past the Nine Elms, parallel with the Richmond Railway, receive, by means of an ordinary sized branch sewer, the Battersea sewage; and, passing close to Wandsworth, receive its drainage, as well as that of Putney; terminating on the banks of the Wandle, near Upper Garrett-green. Branch sewers might convey the sewage of Richmond, Mortlake, Kew, and Barnes, into the Putney Branch sewer; thus preventing the sewage of those places from polluting the Thames, and increasing the fertilising matter at the South Western dépôt.

The length of this tunnel would be about $6\frac{1}{2}$ miles.

The daily average of the Lambeth sewage, (including that of Battersea, Putney, and Wandsworth), will amount to about 2,125,000 cubic feet, or 19,460,783 tons annually.

The clarified surplus water would be discharged into the Wandle.

The tunnels should commence with a height of six feet, and a width of four feet, gradually increasing to the height of seven and the width of five feet. From all accounts, an inclination of one foot per mile would be sufficient. Each terminus to be provided with a sump, from whence the sewage will be pumped into receiving tanks. Within a few yards of the bottom of the sump, parallel with the tunnel, a chamber thirty feet long, by fifteen or twenty deep, should be constructed, for the purpose of enabling workmen to remove the sand, stones, and brickbats, which might be arrested in their course by a dam, two or more feet high (see plan B), as well as by an iron grating; in case of need, strong iron sieves might be placed against this grating, thereby preventing the carcasses of animals, pieces of wood, &c., from passing into the sump. The dam, constructed of wood, might be raised or lowered, according to circumstances, simply by adding or subtracting one or more planks, kept in their places by the pressure of the stream.

The number of tanks, &c., at the north western and north eastern termini, as you will perceive on reference to plan C, will be as follows :—

No. 1 to 4 = 4	of the capacity of 2,000,000 cubic feet each, and		
No. 5 to 8 = 4	„ „	1,000,000	„ „
The Reservoir No. 9, to hold		2,000,000	„ „

The tanks No. 10 to 15, are destined for the manufacture of poudrette ; they may, however, be used as reservoirs in case of need. Each of these tanks to hold about 125,000 cubic feet.

No. 16 is the filtering basin, which should be of the capacity of about 4,000,000 cubic feet. The surface water from the tanks, flowing into this basin, would filter rapidly through layers of sand-stone, charcoal, ashes, sand, and gravel, thus purifying itself ere passing into the Thames, the Lea, or the Wandle.—(See Plan D).

Tank No. 1 communicates with No. 5 ; No. 2 with No. 6 ; No. 3 with No. 7 ; and No. 4 with No. 8, by means of the pipes, *blue* ; and Nos. 5, 6, 7, and 8 communicate with reservoir No. 9, by means of the pipes, *blue* ; and No. 9 communicates with tanks Nos. 10 and 15, by tubes, *blue*.

Tanks Nos. 1 and 4 to be provided with side-cocks, five in number, for each tank, to let off the surface-water by means of the pipes, *yellow*, which will convey the clarified water into filtering basin, No. 16. Tanks No. 5, 6, 7, and 8 to be provided with three side-cocks ; these side-cocks, one foot apart, and placed one above the other. When the contents of tank No. 1 have rested twenty-four hours, the uppermost side-cock is opened, when 200,000 cubic feet of water will be discharged into the filtering basin ; after a lapse of three hours, the second cock will be turned, and so on, until 1,000,000 gallons have been got rid of. The remaining 1,000,000 cubic feet will then be discharged into tank No. 5, where the same process will go on as in tank No. 1,—with this difference, that in lieu of discharging 200,000 cubic feet, 167,000 will be got rid of. When the contents of tank No. 5, as well as those of Nos. 6, 7, and 8, have been concentrated to 500,000 cubic feet, these will be discharged into reservoir No. 9, from whence the liquid manure will be forced into the distributing pipes, by means of an engine.

Plan D.—A is the sump. B the sulphurous acid chamber. C the engine-house and engines for raising the sewage from the sump into tanks Nos. 1 and 4. D is the engine-house and engines for forcing the concentrated sewage into the syphon, 150 feet high. E are the sheds and stores ; and F the offices, &c. &c.

Plan E is a sectional view of the sump, the tunnel, the chamber for collecting stones and rubbish ; of tank No. 1, No. 5, and the reservoir ; of the engine-houses and

syphon. Tank No. 1 to be raised $5\frac{1}{2}$ feet above tank No. 5, which rests on the level of the soil, whilst reservoir No. 9 is sunk five feet below the surface. The earth extracted for tunnelling and sinking the sump would supply abundance of mould for raising the tanks Nos. 1, 2, 3, and 4; for embanking, protecting, and strengthening the masonry, as well as strengthening tanks Nos. 5, 6, 7, and 8. This process would be an economical one, the more so, as the bottom of these tanks might be paved with old bricks and stones, puddled thickly with clay, thereby avoiding the expense of masonry, and at the same time prove perfectly water-tight.

ESTIMATE OF PROBABLE OUTLAY.

Length of tunnel, $5\frac{1}{2}$ miles, at £22,000 per mile	£121,000	
Four tanks, 2 mil. cubic feet each, at £5,000	£20,000	
Four ditto, 1 ditto ditto, 2,500	10,000	
Six ditto, 125,000 ditto, 550	3,300	
One reservoir, 2 mil. ditto,	5,000	
One filtering basin, 4 mil. ditto,	7,500	
Sump, 50 feet deep, by 40 diameter	2,000	
Two engines, 100 horse power each, including pumps, boilers, &c., at £50 per horse power	10,000	
One spare ditto, 50 horse power.....	2,500	
Two engines, 50 horse power each, for distributing sewage manure	5,000	
Sheds, stores, offices, engine houses, implements, tubes, syphon, &c.....	20,000	
Five acres of land	2,500	87,800
		<u>£208,800</u>
Twenty-four-inch main, 10 miles, say £5,000 per mile.....	50,000	
Sluice-cocks, &c. &c., say	2,000	
Connecting same and apparatus, say	10,000	
Service pipes, for contribution, (26 miles, at 7 inch on an average).....	30,000	
Contingencies, say	10,000	
		<u>TOTAL.....£310,800</u>
The same length of tunnel, and same outlay, as N. W. T.....	£310,800	
Length of tunnel, 6 miles, at £22,000 per mile	£132,000	
Four tanks, 1 mil. cubic feet each, at £2,500	£10,000	
Four ditto, 500,000 ditto 1,500	6,000	
Four ditto, 125,000 ditto, 550	3,300	
One reservoir, 1 mil. ditto,	2,500	
One filtering basin, 2 mil. ditto	3,750	
Sump, 50 feet deep by 40 diameter	2,000	
Two engines, 70 horse power each, &c.....	7,000	
		<u>Carried forward 34,550.....</u>
		132,000

North Western Tunnel and Terminus.

North Eastern Tunnel and Terminus.

South Eastern Tunnel and Terminus.

Brought forward	£34,550.....	132,000
One spare engine, 35 horse power	1,750	
Two engines, 30 ditto, for distributing sewage manure ...	3,000	
Sheds, stores, offices, engine-house implements, tubes, syphon, &c.	15,000	
Four acres of land	2,000	56,300
		<u>£188,300</u>
Twenty-four-inch main, 10 miles, say £5,000 per mile.....	50,000	
Sluice-cocks, &c. &c., say	2,000	
Connecting same and apparatus, say	10,000	
Service pipes, for contribution, (26 miles)	30,000	
Contingencies, say	8,000	
		<u>TOTAL.....£288,300</u>
Length of tunnel, $6\frac{1}{2}$ miles, at £22,000 per mile	£143,000	
Tanks, reservoir, basin, engines, &c., same as south eastern tunnel	56,300	
Main sluice cocks, service pipes, same as south eastern tunnel	100,000	
		<u>TOTAL.....£299,300</u>

South Western
Tunnel and
Terminus.

RECAPITULATION

North western tunnel, terminus, and pipes	£310,800
North eastern " " "	310,800
South eastern " " "	288,300
South western " " "	299,300
	<u>Capital required.....£1,209,200</u>

PRODUCE OF CONCENTRATED SEWAGE MANURE.

63,848,000 tons, at 8d. per ton, (exclusive of the extra charge of 6d. per ton from place of distribution)	£2,128,000
Deduct—	
Interest on £1,250,000 at 4 per cent. per annum.....	£50,000
Expenses for working engines, viz.—	
North western tunnel, say, £10,000	
North eastern " " 10,000	
South eastern " " 6,500	
South western " " 6,500	
	<u>33,000</u>
Cleansing, repairs, alterations, &c., say	20,000
Wear and tear of hose, labour for distribution, &c. &c.	50,000
Management, &c.	15,000
	<u>168,000</u>

Probable annual net return.....£1,960,000

Or, as nearly as possible, a return of £1 per individual per annum !

I have endeavoured in the above estimate, to arrive as nearly as possible at the probable outlay of this gigantic undertaking. Not being an engineer, nor an architect, I may have fallen into errors, either in over-estimating or under-rating the cost of the tunnels and termini. Presuming that I have under-estimated the probable cost, even by a considerable sum, provided it prove practicable, the annual returns would still be so enormous, as to warrant the immediate execution of a system on my imperfect, or on more perfect methods than the one I have now the honour to submit to your Honourable Court. Whatever my ideas may be with respect to the merits of highly concentrated manures, manufactured from undiluted human exuviae, which have undergone thorough deodorisation, in combination with other fertilising agents, and which opinions are fully explained in my pamphlet on "Sanitary Reform and Agricultural Improvement," and which I had the honour to dedicate to Her Majesty's Chief Commissioners of the Woods and Forests, I feel convinced that the sewage matter of London should be applied in a liquid concentrated shape only, not in the form of poudrette. In the hope that you will pardon the length of this communication,

I have the honour to subscribe myself,

My Lords and Gentlemen,

Your most obedient humble Servant,

(Signed)

CHARLES T. ELLERMAN.

No. 1A, Beaumont-square, Mile End,
London, 29th September, 1849.

FIAT JUSTITIA.

No. 11, Sidmouth-street, Gray's Inn-road,
16th October, 1849.

My Lords and Gentlemen,

AGREEABLY to your notice, I beg to submit the following as a more concise, and at the same time additional statement, to the proposition I had the honour of submitting on the 1st instant, relating to an extended system of sewerage.

Assuming that the river is the natural channel for the flow and drainage of the surrounding country, my proposition is, to receive the whole of the contents of the drains and sewers into cast-iron reservoirs, or purificators, consisting of two bodies, with three chambers in each, to receive the deposits arrested by the sewage matter being strained in passing from chamber to chamber, and in the last chamber by passing through gravel and charcoal, or peat charcoal, the water be purified; and by rapid percolation through the whole length of the purificator to pass into the river in a clear, pure, and wholesome state, leaving all other matter—earthy, salts, sewage, &c.—in deposits at the bottom of each of the chambers.

This apparatus being applied to every town on the banks of the river, viz., Richmond, Kingston, Windsor, Henley, Oxford, &c., and a prohibitory act passed that no sewage matter unfiltered and unpurified, shall be allowed to pass into the Thames from London up to its different heads, the whole of the water in the river would then be preserved in all the purity of its sources, and its wholesome nature and qualities not be polluted or invaded.

In this case, *water works*, for the supply of London and the towns on the banks and proximity of the Thames, may be established, freely deriving their supply from this ample and unpolluted source, and pumped up to reservoirs of heights commanding the upper stories of the houses and buildings.

Another most important object would be gained,—the whole of the coasting and foreign shipping visiting the port of London, would be supplied with this element of life in a pure and wholesome state, which is not the case at present, nor will it be, if the sewerage of London alone be contemplated, or be carried out by tunnels.

The economical removal of the sewage water remaining in the reservoirs, and the three qualities of deposits, by means of iron-covered barges, from each end of the reservoirs, up or down the river, to any required distance.

I beg to acknowledge an error in my former statement, in the computation of time, when the reservoirs being about half full, will require to be cleansed out, which has arisen from the want of information as to the probable quantity of deposit; therefore, instead of four or six months for an apparatus, or reservoir, of the dimensions laid down on the plan, read four or six weeks. This does not affect the principle of the apparatus, the size of which, if necessary, may be increased in capacity or extended in length, so as to form a receptacle equal to the time mentioned in my former statement, if this should be required.

I have the honour to be,

My Lords and Gentlemen,

Your most obedient humble servant,

(Signed)

FIAT JUSTITIA.

To the Metropolitan Commissioners of Sewers.

CHARLES FOWLER, Esq.

THE only further object which I beg leave to submit, in regard to my plan and suggestions for improving the drainage of the Metropolis, is with a view to obtaining a—

Better Supply of Water ; as being essential to keep the sewers in a clean and healthy state ; and which comprises the following considerations, viz :—the Water Companies are the only *present* means available ; their powers and ability to meet the additional demand ;

Their contributions (hitherto gratuitous) towards the flushing of the sewers ;

The great scouring power to be obtained from the reservoirs in the parks, &c. ;

The difficulty of interfering with the private drains ; penalties for their being allowed to become foul or offensive ;

The great value of the flushing water in dry weather, which, when pumped into the country for irrigation, will more than repay its cost ;

The companies willing to supply water for public uses at the cost of pumping.

PLAN FOR INCREASING AND IMPROVING THE SUPPLY.

Review of the rise and establishment of the Water Companies.

Remissness of the public in allowing their interests to pass into the hands of commercial bodies.

Doubtful policy of buying up those vast establishments, and their vested interests.

Their present returns moderate, and obtained after great difficulties and delay.

A better supply now urgently necessary, for sanitary purposes ; particularly for the use of the poor, who cannot pay water rates.

These objects to be effected at the *public expense*, therefore the procuring the water must be a *public work*.

There is no chance of its being undertaken as a *commercial speculation*, as it holds out no prospect of a *profitable* return.

The mode of proceeding proposed, is to have recourse to the sources of the several tributaries of the Thames, on both sides of its course : to convey these streams in *direct* lines to the environs of the Metropolis ; and thus to obtain an elevation of level, and power for distribution.

The water to be delivered into the existing reservoirs, and such additional ones as may be required: the Companies paying an equitable price for the same, according to quantity, and to the actual cost of their present supply.

A controlling power to be reserved to the public, to ensure the accomplishment of the public objects before mentioned.

With this view, surveys should be made of the surrounding country; plans laid down, and estimates formed, for carrying the requisite works into effect.

(See Survey by Telford, and Report laid before Parliament, in 1834.)

An Act of Parliament will be required to create the proposed authority, viz., a central board, which may be incorporated with the Board of Health, with powers to raise money, and assess the several parishes, in order to liquidate the principal, and defray the interest and annual expenses. Also, to have an efficient staff of officers, to direct and superintend the operations; to control the accounts, &c., &c.

In conclusion it may be stated, that the whole of what is now proposed, may be effected, without any undue interference with vested rights or interests, and with the greatest practicable economy. Also, that it will effect a great improvement in health and cleanliness, particularly among the poorer classes.

(Signed) CHAS. FOWLER,

Gordon-square, 9th October, 1849.

The Honourable Commissioners of Metropolitan Sewers.

WILLIAM YATES FREEBODY, Esq.

9, Duke Street, Westminster,
October 16th, 1849.

To the Commissioners of Sewers.

My Lords and Gentlemen,

IN conformity with the resolution requiring a concise statement of my plan for the better drainage of London and its vicinity, I,

FIRSTLY, direct your attention to the absolute necessity of a SUPPLY OF WATER: and therein indicate the source of an unbounded supply—the means and line of transit being so chosen as to effect that object in the most practicable yet

economic manner (The estimate for the land and works is £135,000—equal to an annual charge of £5,400);

That the *present system of sewers* ARE USEFUL, and, WITH a proper supply of WATER may be rendered efficiently workable in conformity to an ascertained datum;

That the converging system, if adopted, WOULD, likewise REQUIRE an *additional supply of water*;

That any purposed application of sewage manure to agricultural purposes, WOULD also REQUIRE an *additional supply of water*;

That the OUTFALL, being of the greatest importance, *should be the first point settled*;

That the river Thames offers the best (because the lowest) *natural* out-fall, by reason also of its having for centuries been found the receptacle of sufficient capability, aided chiefly by the agency of its downfall waters, there appears little reason to doubt its future fitness; for, hitherto, nothing has been done to purposely achieve the object in view; and yet, the river near London is less generally offensive than it was ten years ago. If the power of the mechanical action of the river—irrespective of its chemical and tidal changes—admitted of accurate calculation, it would be found that there is, semidiurnally at work, a natural engine or agent of nearly 6000 horse power, that would cost £200,000 to re-establish, and require an annual outlay of £120,000 to keep it at work.

Should you elect to continue the drainage of the Metropolitan sewers to the river Thames, I have

SECONDLY, to direct your attention to the mode I propose of FLUSHING *that part of THE CHANNEL of the RIVER between Battersea and Greenwich*. I purpose to effect this *by placing ACROSS the RIVER, near Wandsworth, A SOLID DAM OF MASONRY, pierced by seven locks*; at a cost of £145,000. The lock-gates may, very generally, be kept open, and the water-way therefore unimpeded; but, *whenever the channel of the river, through London, required cleansing*, the action of this work, when about to be employed, would be as follows:—during *the flow* of the tide the gates would *all remain open* until high-water. From the time of high-water, the gates (except for passing vessels) would remain *closed for about two-thirds of the time of EBB-tide*; and the channel of the river, up to Teddington Lock, would thus become, for above twelve miles, one vast lock-pool; any quantity of the water so conserved might then be passed through London with a velocity perfectly controllable. This dam and locks would give to the river in dry and hot seasons the benefits it

now receives from land floods in the rainy or winter months—by the removal rapidly of impurities further seaward. At present there exists no agency under your control whereby the removal could be ensured of any considerable quantity of fœtid matter deposited in the channel of the river; but by means of the sluice area of this proposed dam, the rate of current *could be so governed*, as to permit (but not to exceed) *the* observed *velocity* generally *consequent* on ordinary freshes.

The channel of the river would be improved for drainage purposes if contracted to an uniform width, and the sectional area judiciously regulated.

The minor sewer outlets require also to be united, and the outfall then decided on should be properly graduated between high and low-water marks.

If quays or promenades can be profitably formed, longitudinal catch-drains should be worked therein; but a careful examination of the area drained here becomes necessary, for I would be understood as *not* to recommend too large an area of drainage to any *one* outlet, because of the danger to those works consequent on sudden storms, over any district of such great extent and varied heights as that existing northward of the Thames near London.

I have the honour to be,

My Lords and Gentlemen,

Your most obedient and very humble Servant,

(Signed)

WILLIAM YATES FREEBODY.

ALFRED GILES, Esq.

The drainage and sewage of the Metropolis to be combined and carried away by two intercepting culverts; one to be constructed on each side of the river Thames, as near as possible to the shore line or high-water mark, so as not to interfere with any wharf property.

The culvert on the north side of the river to commence at Chiswick at four feet diameter, and to terminate at a depôt on the East Ham Level, near the river Roding. The largest diameter of this culvert to be ten feet; the extreme length, eighteen miles; the construction to be of brickwork in cement. The level at Chiswick to be three feet above low water; that at the depôt to be fifteen feet below low-water.

The culvert, on the south side of the river, to commence at Putney, at four feet diameter, and to terminate at a depôt on the Plumstead Marshes, adjoining the bank of the river. The largest diameter of this culvert to be seven feet; the extreme

length seventeen miles ; the construction and levels to be similar to those of the north culvert.

The dépôt, on the north side, to consist of a receiving basin of fourteen acres in extent ; of sixteen pumping engines, each of 108 horse-power, and of eighty filtering beds, from which channels for the filtered water will lead into another basin to communicate with the Thames by means of a lock, through which vessels may come in and receive cargoes of manure. The extreme lift of the pumping engines to be thirty-five feet. The sixteen engines are provided against extreme cases ; in ordinary weather, four engines will be sufficient for pumping up the sewage ; they are so arranged as to admit of separate repair.

The dépôt, on the south side, to be of similar construction to the above, but proportionately smaller.

The estimated cost of these works is as follows :—

For the north culvert	£528,616
For the north dépôt	436,870
For the engines, pumps, and engine-houses	210,000
Total for the north side	<u>£1,175,486</u>
For the south culvert	£488,890
For the south dépôt	270,000
For the engines, &c. . . .	130,000
Total for the south side	<u>£888,890</u>
Total estimate	<u><u>£2,064,376</u></u>

The advantages claimed for the foregoing plan, are,—

1st. The intercepting and collecting of all the London sewage before it reaches the Thames ; so that not even the washings of the streets would be allowed to pollute the river water.

2nd. The outfalls of the existing sewers could be lowered wherever it might be necessary.

3rd. The periodical obstruction of the outfalls by the tide would be avoided ; and the stream of sewage being thus made continuous, there would be less tendency to the formation of deposits in the existing sewers.

4th. There would not be any currents of air passing up the sewers, the outfalls being ventilated by means of lofty shafts, would cause the direction of the currents to be reversed; and the currents of air might be further assisted by gas burners in the shaft.

5th. The plan of combining the drainage and sewage, would, with the improved outfalls, obviate the necessity of artificial flushing.

6th. The self-acting traps, leading out of the air-shafts, will prevent the possibility of damage by floods during heavy falls of rain; whenever such extreme cases occur, the sewage water, discharged into the river, will be so much diluted as to be scarcely worse than ordinary land drainage.

7th. The plan of adopting the existing sewers as tributaries to the intercepting culverts, would be manifestly superior, in point of economy and convenience, to any plan that meditated a general alteration in the levels and directions of the said sewers.

8th. The drainage of remote districts, not connected with London, is excluded.

9th. The sewage manure may be either distributed in a liquid state, or it may be sold in bulk after it has undergone the filtration process.

10th. The sale of the manure will yield an ample return for the expenses incurred.

(Signed)

ALFRED GILES.

16th October, 1849.

MESSRS. GREAVES AND BARLOW.

Manchester, Ducie-place,

Oct. 12th, 1849.

To the Commissioners of the Metropolitan Sewers.

Gentlemen,

IN compliance with the circular received on the 8th of October, we beg to inform you that the general features of the plan we submitted to your notice, consist, First, In placing a sheet-iron tunnel along each bank of the Thames, into which all the sewage would be collected from the north and south banks; Secondly, In agitators, acted upon by the tides, to prevent the sewage matter from choking the tunnels; and, Lastly, In self-acting apparatus for sluicing the tunnels at every tide, if necessary.

We remain, Gentlemen,

Respectfully yours,

(Signed)

HUGH GREAVES.

H. B. BARLOW.

FRANCIS HAWKES, Esq.

To the Commissioners of the Metropolitan Sewers.

My Lords and Gentlemen,

IN compliance with the resolutions passed at the Court of Sewers, held on the 3rd instant, I beg to forward a statement of what I consider to be the main features of the scheme, which I had then the honour of submitting to your consideration.

First. Two lines of drainage, or main culverts, with natural outfall, as described in the accompanying sketch by red lines. The one commencing at or near the village of Teddington, and passing, in a parallel direction with the river Thames, through Brentford, London, and West Ham Marshes; thence by an open drain across Plaistow and East Ham Levels, and terminating in the river Thames at Dagenham Creek. The other commencing between Kingston and Petersham, passing through Richmond, Clapham, Camberwell, Greenwich, Woolwich, Erith, and thence by open drain across Crayford, Dartmouth, and Stone Marshes, and terminating in the river Thames about one mile west of Greenhithe, by which all other sewers are proposed to discharge their contents.

Second. The exclusion of tidal water from the sewers, and the enlargement of the channels near their respective outfalls, sufficiently to form reservoirs for the accumulation of sewage and downfall water, during the period of flood tide, from which they would be protected by tidal or dock gates, to be opened immediately upon the tidal water receding to the level of the sewage water in the reservoirs, when their contents would be discharged into the river. It is of obvious importance that ample area should be allowed for these reservoirs, so that the danger of inundation from the accumulations may be obviated.

Third. The construction of tumbling bays, or sluice gates, in connection with the water above Teddington Lock, for the purpose of supplying the main sewers with a copious and continual stream of water, without the aid of steam power, to be admitted during the period of ebb tide, thereby effectually carrying off the sewage to its outfall, as well as cleansing the bed of the sewage reservoirs.

Fourth. The cleansing of the drains in the low localities of Westminster, Chelsea, and Walham Green, on the Middlesex side of the river Thames; and those of Lambeth, Kennington, and Bermondsey, on the Surrey side. To effect this object, I purpose laying down from the river Thames, at Teddington Lock, and somewhat above the level of the lock floor, two eighteen-inch cast iron pipes, one to pass on the Middlesex side of the river, through Brentford, terminating at Hammersmith; the other to pass on the Surrey side, through Richmond, ter-

minating at Battersea. Branching from the end of each of these, I propose to lay down two lines of pipes, one of three inches in diameter, to be carried in the direction of, and to communicate with, all the minor drains, so as to supply them with a continual flow of water. The other of twelve inches in diameter, which would be under control, to communicate with the principal drains, for the purpose of discharging into them periodical flushings, to be turned on when the accumulations in the sewage reservoirs are flowing out with the tide, and to be shut off when the tide returns as high as the floor of the tidal or dock gates.

Fifth. The flushing of the sewers in the high levels to be effected by the supply of water, at high pressure, from the reservoir at Kingston-hill.

Sixth. The ventilation of the sewers, by giving an increased height to the principal culverts, the ends of which will at all times be open to the atmosphere.

Seventh. Being of opinion that the most perfect scheme of drainage would but partially supply the sanitary wants of the population of London, without a constant and abundant supply of pure water,—I purpose abstracting from the river Thames, at the upper level of the Teddington Lock before mentioned, below which the tidal influence terminates, and where the Thames supply ceases to be of use either for navigable or mill purposes, 84,000,000 gallons, for domestic, manufacturing, and flushing purposes every twenty-four hours, or thirty-five gallons for each individual, assuming the population of London and the suburban districts to be 2,400,000. And I would take 10,000,000 gallons more for fire mains and other contingent requirements.

This supply I purpose lifting by requisite steam power into reservoirs, intended to be constructed on the table land of Kingston-hill, which I find to be 165 feet above Trinity high-water mark; each reservoir occupying an area of not less than seventy-five acres, and to contain three days consumption; a diagram of the proposed form of which is here subjoined. From the extreme ends of the filtering chambers which form part of the plan of the said reservoirs, the supply mains will proceed. These mains are intended to take two directions; one pursuing its course over the river Thames, thence just below the Hampstead and Highgate Hills, and terminating at Tottenham; the other extending, through Tooting and Lewisham, to Woolwich; hence it will be seen that the Metropolis, including all the populous suburban districts, might be constantly and abundantly supplied, at high pressure, with pure filtered water.

In my Report I have suggested that the diameters of the supply mains should be three feet each; but on considering the effect of the contemplated junction of both mains, I am of opinion that their diameters might be reduced to two feet; but as

this is a portion of the scheme requiring close calculation, the adoption of any particular size cylinder would of necessity depend thereon.

The courses of the supply mains are described in the accompanying sketch by blue lines.

I have the honour to be,

My Lords and Gentlemen,

Yours very respectfully,

(Signed)

FRANCIS HAWKES,

45 and 46, West-street, Reading, Berks.

Civil Engineer.

17th October, 1849.

THOMAS HAY, Esq.

To the Commissioners of Sewers,

My Lords and Gentlemen,

OWING to the resolutions passed at a Court of Sewers held on the 3rd instant, and having already taken the liberty to address you on this important subject, I now beg leave to offer a few additional remarks, as briefly as I can, on the plan I propose for ventilating the sewers of London, the necessity for which is daily becoming more and more apparent.

I proposed in my former paper, that for the purpose of effectually carrying out my plan, it will be necessary to divide London into districts, and in each district build a shaft of certain dimensions, to be calculated from the extent of area to be ventilated by such shaft.

There should be an uninterrupted communication between the shafts and the sewerage of the districts in which they may be situated, so as to enable the shafts to suck up every particle of pernicious vapour generated in the sewers, and prevent their escape as at present, through the gully-holes, &c.

There can be no doubt that whatever plan may be adopted for the effective drainage of the Metropolis, it must be one on a gigantic scale, and necessarily will involve a number of years in its completion; and even when complete, it will not remove, but perhaps may, in some degree, diminish the evil, of the escape of obnoxious gases from the sewers and drains to the streets and houses.

The emanation of mephitic gases will always go on, however effectual the drainage may be, and their admixture with the external air must necessarily be the consequence, unless other vent-holes than those in the streets be provided for their

escape. It is therefore clear, that without proper ventilation, the sewerage, under any form of construction, cannot be rendered innocuous.

The great benefits to be derived from an effective subterraneous ventilation do not confine themselves to the purification, or to prevent the contamination of the air we breathe; but by having a constant current of air passing through every part of them, it will effectually render the sewers themselves beyond the possibility of their retaining in any part of them an accumulation of gases, so as to apprehend explosion or suffocation at any time, and thus they may at all times be entered for the purpose of cleansing or repairing, without any fear or risk to the men employed.

This system of ventilation will not be in the way, or at all interrupt the carrying out of any great plan for drainage; but may be made to answer this as well as the sewers in their present state, and the requirements of such enlarged and improved plan will demand such an auxiliary as well, although, perhaps, not to the same extent as the present sewerage; so that, under any circumstances, it appears to me that a system of ventilation of the sewers cannot be dispensed with without perpetuating the abomination to the population of London, of being obliged to inhale poisonous if not deadly vapours.

It may be argued, perhaps, by some, that the vapours from the sewers being carried out through one vent-hole, such as a shaft, and discharged at an elevation, will fall again to the earth, and be equally pernicious; but this is impossible: from the great quantity of atmospheric air which will be thrown into the sewers, it will so commix with and dilute the gases, that although they will be carried off by the current and discharged at the top of the shaft, they will be rendered perfectly harmless, from the dissemination of the particles through the atmospheric air; and, instead of descending, as most gases are specifically lighter than the atmospheric air, will float therein.

It would only, I am afraid, take up too much of your valuable time to comment further on the advantages to be derived from a perfect system of ventilation; and I will only add, that if the few hints I have thrown out on this engrossing and important matter be worthy of your further consideration, I shall be happy to attend, with the drawings I have prepared, to give any further information on the subject you may require.

I have the honour to remain,

My Lords and Gentlemen,

Very respectfully your obedient Servant,

(Signed)

THO. HAY,

Civil and Mining Engineer.

5, Adelaide Place, London Bridge,

October 12th, 1849.

CHARLES HENMAN, Esq.

1st. *For the drainage of Houses.*—I propose glazed earthen pipes, as at present used, but that they should be made in *longer lengths*, and not less, in any case, than six inches in diameter; also the adoption of an *air trap* to each drain (in addition to the usual stink traps), to communicate with the kitchen, or some other convenient flue.

2nd. *The sewers in streets or public ways* to be built on the principle shown by the sketch in the margin, and all old sewers to be altered to the same principle. The upper sewer is intended to receive the surface water *only*—the lower sewer the house drainage; by the adoption of this principle no traps will be required to the gully-holes, and all offensive emanations from the gully or air-gratings will be avoided; the sewers can be ventilated at pleasure, without danger of offensive smells; the upper sewers will always be perfectly clean and free from impurities, they would form subways, by which the lower sewers can at any time be flushed or cleansed; and after the first construction of efficient sewers on this principle no disturbance of a roadway on account of the sewers need take place for *ages*.

3rd. I propose that the upper, or surface water sewers, shall empty themselves into the river Thames as at present, but, as *a substitute for the river Thames* (to receive the contents of the lower, or foul sewers), I propose the construction of *two* deep subterranean “tunnels,” one on the northern side of the Thames, to intercept all the sewage on that side of the river, as more fully described in my letter to the Commissioners; that on the south side to intercept the remainder of the sewage, *both* tunnels to fall *from* the Metropolis, *one* to the *east*, the *other* to the *west*—*both* to be *perfectly straight*. The western tunnel to be seven miles in length, the eastern tunnel six miles in length, conveying the entire body of sewage either to the eastern or western depôts. The extent of country to be drained to these depôts will be $10\frac{1}{4}$ miles from north to south, and twenty-three miles from east to west. I have declined to furnish any section of the “tunnel,” as its consideration involves many grave and important points, which can only be solved by a study of data which has not yet been furnished to the competitors, and which they are not in a position or authorised to procure for themselves.

4th. As a certain amount of subsidence does take place in every channel through which impurities are allowed to flow, it may be anticipated in these “tunnels,” although care would be taken to reduce that subsidence to a minimum: first, by providing a considerable fall; second, by the tunnels being in comparatively short lengths; third, by having a constant flow throughout their length; fourth, by reducing the friction of the channel to a minimum, which would be effected by a curved bottom and sides with a glazed surface, and by building the tunnels *perfectly*

straight. Notwithstanding all precautions, however, it may fairly be anticipated that subsidence, to a certain extent, will take place; and, however slowly, its natural effect, if left to itself, would be—first, to impede the flow of sewage, and ultimately to choke up and render useless the tunnel; to prevent this, mechanical means must be resorted to, and it appears to me that one or both of the following methods may be adopted :—

1st. Periodical flushing (say once in every nine or twelve months); for this purpose any desirable force of water can be obtained from the Thames at the highest point of each tunnel, the natural and immediate effect of which would be to scour out and cleanse the entire tunnel, from its commencement to its outfall at the depôt, and the expense would be inconsiderable, being merely the cost of pumping up the water used for the purpose. Should this method, however, be found insufficient to overcome the tenacious adherence of the soil, I propose,

2nd. The construction of a machine, which might be termed a rotatory travelling scraper, or rake, which, being worked either by the flow of the sewage only, or aided by steam power, compressed air, mechanism, or otherwise, could at intervals be made to travel up or down the tunnels to rake, loosen, and detach those tenacious impurities which may have adhered to the bottom, and these would then, without difficulty, be carried off to the outfall by the next flush. By these means I consider the tunnels could, at an inconsiderable expense, be kept for any length of time perfectly clean and free from deposits, and that all objections to a “tunnel scheme,” founded merely on its liability to choke, are untenable.

(Signed)

CHARLES HENMAN,
Architect.

7, Millman-street, Bedford-row.

J. B.

To the Gentlemen Commissioners of the Metropolitan Sewers.

13, Kennington Place, Kennington Common,
October 10, 1849,

THE concise particulars of my plan of sewage for the Metropolis, consist in the following :—

One straight line of sewer, from Kew-bridge to Charing-cross, where it will get a gentle curve for a short distance, and then run straight to Barking-creek, where it is to empty itself into a large filtering reservoir; the filtered water running into the Thames at half high-tide.

The bottom level of the *sewer to be one foot below the low-water mark at neap-tide, at Kew-bridge*; so that you can have an average rush of water of 4 feet 6 inches, at any time, or times, or at all times, emptying itself into the reservoir, at Barking-creek, at half high-tide; or shut out the sewage by gates, from the reservoir,* and let it run into the river. So that at all times, in any season, you can have an impetuous rush of water, of 4 feet 6 inches, mixing with the house drainage, sweeping all before it. The sewer, as laid down in my plan, is to be 18-inch walls, and nine feet in the clear, from end to end; shafts of twelve feet diameter, where you can get them, and as thick as you can get them.

The bottom of the shafts to be two feet below the sewer, forming a cesspool for the sediment, which may be dredged up at convenience, or otherwise, as circumstances may require. This being the case, from a sewer thickly studded with shafts upon this principle, will prevent the sewer *ever having* any accumulation of sediment or soil upon its bottom; from which, together with the rush of clean water that *may be let in*, and the many shafts for the double purpose of letting in the air and clearing out the sediment from the bottom of the said shafts, the said sewers must, as a matter of course, have a draught of air through them, amounting to a good fresh *breeze*.

The said new tunnel sewer to take in every other sewer *in its course*; so that the drainage will, at every shaft, leave its sediment in the cesspool of each shaft. So that the sewage will be filtered by such means before it reaches the great reservoir at Barking. It cannot be necessary to dredge the reservoir more than once in seven years. The bottom of the said reservoir to be laid upon a principle by which it can be dredged at little expense. The dredgings or soil may, in the locality of Barking, be profitably disposed of, it being good manure. But sewage water is not sewage *sediment*; and the scheme of steam-engines and sewage water-works, for its distribution, is little short of madness.

I have, I believe, sufficiently explained all points but one, and that is, the fall from Kew-bridge to Barking. You may see, by a minute inspection of my plan or section sent in, and signed "J. B.," that the terminus of the sewer bottom is half high-water mark, level at neap-tide, and one foot below neap-tide, low-water level at Kew; and running in nearly a straight line, will give an impetuosity to the rush of water of double the current of the river; so that you will have a force of water six hours, between high-tide and high-tide at Barking-end—a rush of water that would sweep a town down. Each shaft is to have three apertures, communicating with an outlet into the river, to guard against the town being flooded in the event of heavy rains at high-water. And with regard to the strata of earth the tunnel will run through, it is to me of no consequence. *Prove that it is, who can.*

* Or shut It the Swer By Gates off' ofe the Reservoy, &c.—*Original Manuscript.*

Your drain-pipes are too small, and of the wrong material. They ought to be iron, upon the same principle, but very considerably larger in the bore.

My plan, although rough, contains facts and figures of calculation *that cannot be put aside*. Please to refer to them. Although my plan is rough, it is correct.

The section I would have set to a scale; but the sewer level, with respect to its length, could not be shown better. You will perceive by my plan, I contemplate a similar sewer, of equal length, entirely straight from Twickenham to Plumstead Marshes, upon the south side of the Thames. For EXPENSE, see my plan as sent in.

I may be permitted to apologise for the roughness of my plan, as sent in. I am not the man to waste time upon a very pretty highly-finished plan. I have been all my life a practical *drudge, giving knowledge to theorists*.

To make security double secure, you may have a large air-pipe between shaft and shaft, cradled up above the houses.

J. V.

To the Metropolitan Commissioners of Sewers.

Gentlemen,

I SENT to the late Board of Commissioners a short letter, under the date of the 8th of September last, objecting to Mr. Phillip's plan of one huge tunnel of nearly twenty miles length, and suggesting an arrangement of a number of lengths of tunnel, running in various directions, and so connected by means of shafts or wells at their extremities, that each length of tunnel should be always full, and the liquid soilage should everywhere, in the shafts, stand at the same level, and be passed from one to the other until it should reach the outskirts of the Metropolis.

Having seen since, in the *Morning Chronicle*, a classification of the plans which were first sent in, I am confirmed in the impression, that such an arrangement of connected lengths of tunnel as I propose, is not far from the most correct and advantageous system ever likely to be devised; I therefore beg leave shortly to enumerate the main points of the plan which I advocate.

First. A series of lengths of tunnel, varying from half a mile to a quarter, or even in some cases less, according to locality; those nearest to the river to be in general the shortest, those farthest from the river the longest.

Secondly. These tunnels to be so capacious that they may readily be traversed by men when occasionally emptied for cleansing, and so substantial as never to require disturbance.

Thirdly. No opening, if avoidable, to be in any of these lengths, save at their extremities; if unavoidable, as at the termination, perhaps, of a cross street, the opening to be by a connected upright shaft.

Fourthly. The lines of tunnel to diverge in general from the river, north and south, at right or oblique angles; to decline, also, from the river, but with no greater fall than is necessary.

Fifthly. At each extremity of a tunnel a spacious shaft or well to be constructed, with four or more smaller shafts about the principal shaft, and communicating with it at the bottom; into these smaller shafts the soilage of the streets in the immediate vicinity is to be discharged.

I propose these lateral shafts for the facility of cutting off the communication between any lengths of tunnel, main or subsidiary, and the central shaft, so that the cleansing of each of them in succession may be easily effected.

Such are the main points; but to make more clear my ideas, I will suggest, that one main shaft, A, be sunk opposite the Town-hall, Southwark; a second shaft, B, in the open space near St. George's Church, in the Borough; a third, C, at the Queen's Bench Prison; a fourth, D, at the Elephant and Castle; a fifth, E, at or near the Bricklayer's Arms, in the Kent-road; a sixth, F, not far from Blackfriars'-bridge; a seventh, G, at the Obelisk.—[See diagram in original manuscript.]

The drainage of the houses from London-bridge, to be conveyed by two tubes H and I, one on each side of High-street to a small shaft, K, near to, and communicating with shaft A at the bottom by a tube, L; the liquid soilage would then flow from the water-closets and sinks of each house in High-street, along the two tubes H and I, into shaft K, and thence through tube L into shaft A. In the two shafts K and A, the soilage would rise to a general level-line, $m n$; it would then discharge itself down a tunnel O, into shaft B; after rising in the shaft B to the level-line $m n$, it would flow along a tunnel P, into shaft C; fill C up to line $m n$, and then pass through a tunnel Q, into shaft D. The soilage of the streets near to shafts B, C, D, to be conveyed by tubes, which should empty themselves into small shafts around B, C, and D, and communicate with them in the same manner as K and A communicate.

Shaft B might empty itself, in part, by a tunnel or tunnels passing along Dover-street into shaft E; shaft D might also, by a tunnel along the New Kent-road, empty itself also, in part, into shaft E.

Shaft F would collect the soilage of the streets about Blackfriars'-bridge, and,
[SECOND SERIES.] K

by a tunnel along the Blackfriars'-road, discharge itself into shaft G ; this again, by a tunnel along the London-road, into shaft D ; the shafts at the Obelisk and Queen's Bench, G and C, might also be connected.

A series of tunnels from the Bricklayer's Arms, might proceed along the Kent-road towards Plumstead Marshes, and discharge thereabouts into the Thames all the surplusage sewage, acting as a safety-valve to all the tunnels and shafts on the south side of the river.

Another series of tunnels might proceed from the Elephant and Castle, along the Walworth and Camberwell-roads to Camberwell-green ; and a third series along the Kennington-road to Kennington-common, and thence beyond, in various directions. Thus shaft D might have three outlets ; and, in fact, a net-work of tunnels and shafts might be spread beneath the surface at the Surrey side of the Thames, extending in all directions, admissable at any future time of farther extension, and forming a complete underground communication, so that the liquid manure might be drawn off to any part of the suburbs, and there be applied to agricultural purposes.

A moveable pumping-apparatus, similar to a fire-engine, might be employed to empty the tunnels in succession, that each might be thoroughly cleansed.

I am Gentlemen, very respectfully,
Your obedient servant,

(Signed) J. V.

Camberwell, October 17, 1849.

JAMES E. MAC CABE, Esq.

23, Parliament-street, Westminster,
11th October, 1849.

Gentlemen,

IN accordance with the resolutions passed by your Board on the 3rd inst., and communicated to me, through your Secretary, by circular of the 5th inst., I forward as concise a statement of the main features of my plan as the case will admit of ; it being requisite that I should make a few observations in support of the data upon which I have founded my plans.

The main features of my plan, forwarded to you, profess to remedy the present evil by passing a plentiful supply of water through the sewers, when altered to agree with them, which makes the river the channel through which I propose disposing of the sewage.

I could not advance a stronger argument in favour of my plan of thoroughly washing out the sewers throughout their course into the river, as regards sanitary measures, than the fact of the great decrease of cholera since the commencement of the late heavy rains, which has forced a partial cleansing of the accumulated fetid matter from our over-gorged cesspools, misnamed sewers.

The efficiency of cleansing the house-drains, as directed in my Report of the 18th of August, has been fully proved in my residence; the fumes from the drains of which, during the dry weather, were quite insupportable; so much so that we were obliged to put damp cloths over the sinks in order to keep down the noxious effluvia arising from them; but taking advantage of the additional supply of water, I conducted it into the drains, as proposed by my Report, and have thereby removed the nuisance.

If the improved sanitary state of London be the object desired to be gained, it is my decided opinion, that any attempt to save the sewage manure of the city, will only tend to aggravate the evil sought to be abolished; as any plan that does not profess to assist, by a plentiful supply of water, the removal of the soil passed into the sewers from water-closets, must only tend to increase the present nuisance; and if the supply of water required for the cleansing of them be used, we might as well propose to make a profit of the Thames water as manure at once, without constructing artificial receptacles for it, at an enormous expenditure of both capital and time.

It appears to me to be consistent with common reason, that should we thoroughly cleanse the sewers by the uniform supply of water (as directed in my Report) into the Thames, and thereby materially facilitate the passage of their deposits into the sea, we should, at the expiration of twelve months at furthest, find the river water in London as pure as it is at present at Gravesend; for beyond this quality we never can expect to make it, as we cannot prevent its always being a general cesspool for our floating city of ships; even admitting that we did succeed in preventing the discharge of house sewage into it by artificial means, the above cause must always remain.

To prove that I do not advance any theory, that cannot be borne out by practice, I beg to say, that could I not procure the supply of water required through any other means, I should establish waterworks in the most convenient position on the banks of the river (as the water of the full tides will be sufficiently pure for that purpose) in order to supply the different reservoirs as directed in my Report.

I have the honour to be, Gentlemen,

Your obedient humble servant,

(Signed)

JAMES E. MAC CABE,

Engineering Surveyor, &c.

To the Metropolitan Board of Commissioners of Sewers,

1, Greek-street, Soho.

J. R. M'CLEAN, Esq., C.E.

17, Great George-street, Westminster,
1st October, 1849.

THE main sewer on the north of the river Thames, shown on drawings No. 1 and 2, and marked A, B, C, is to commence near Battle-bridge, King's-cross; it is to intercept the river Fleet, where it crosses the City-road, leaving the present sewer available for flood water only. It is thence to pass under the City-road, through Islington, and under the Regent's-canal, westward of the City-basin, from that place it is to pass parallel to the Regent's-canal, and nearly adjoining it as far as the Victoria-park, and thence along the south end of the Park, in a southerly direction, passing under Sir George Duckett's-canal, the Eastern Counties and West India Dock Railways, and under the river Lea, south of the East London Water Works, out to the river Thames, passing along the North Woolwich Railway for the whole distance from to the Bow-road to the river Thames below Blackwall.

The total length of this main sewer will be seven miles, seven and a half furlongs, and the average size about ten feet diameter, as far as the river Lea navigation, from which place to the outlet of the Thames (a length of about three miles) the sewer will be fifteen feet diameter, and capable of holding 60,000,000 gallons, or the greatest quantity that can pass into it, during the time of flood tide. The enlarged portion of the sewer is also to be available for the disposal of the sewerage for agricultural purposes. In case it is considered desirable, it may be conveyed in a fluid state, in pipes, along the Regent's and Grand Junction Canals, to reservoirs at different elevations, as far as Watford, and thence be allowed to descend by gravity into the great agricultural district, north of the Chalk-basin; or it may be precipitated daily in reservoirs, running parallel to the sewer, from which the fluid may be drained off at low-water, bearing the solid manure to be manufactured for export, in a situation well adapted for the purpose.

SECOND CLASS SEWER, A¹A.

This sewer is to commence near the Regent's-canal, where it crosses the Hampstead-road, at which point it will receive the sewerage from Hampstead, and a constant supply of water from the Canal; it is thence to pass in a southerly direction along the road as far as Southampton-street, receiving in its course the sewerage of Kentish-town, and intercepting the sewerage at present passing into the river Fleet, and thence along Gloucester-place, nearly parallel to the river Fleet, down to King's-cross, where it will empty itself into the main sewer A, B, C.

SECOND CLASS SEWER, A²A.

This sewer is also to commence at the Canal near Paddington, for the purpose of receiving a constant supply of water. It is then to pass along the Edgware-

road and along Oxford-street, intercepting in its course the King's Scholar's-pond sewer, passing over the Regent's tunnel sewer, and receiving as it passes along Bedford-square, Russel-square, and Brunswick-square, the whole of the sewerage of the high districts north of Holborn; from Brunswick-square it is to pass on the north side of the Foundling Hospital, and thence along Gray's-Inn-lane to the main sewer at King's-cross.

SECOND CLASS SEWER, B¹, B³, B.

This sewer will intercept the sewers at present passing on the west of Finsbury-circus, and will also receive the sewerage north of London-wall and Smithfield-market. It is to pass along Houndsditch, Whitechapel, and the Mile End-road (intercepting the existing sewers) and into the main sewer A, B, C, near the River Lea navigation.

SECOND CLASS SEWER, B² B³

This sewer will intercept the whole of the low level sewerage of London, above the influence of the tide, north of the River Thames. It is to commence in Hyde-park at the Ranelagh sewer, the sewerage of which it will receive, and also a supply of water from the Serpentine. It is then to pass in an easterly direction through Curzon-street, where it will intercept the King's Scholar's-pond sewer, and thence to Piccadilly, along which it is to pass, intercepting in its course the Regent's-street sewer, and passing over the Regent's tunnel sewer. It is then to pass along the Haymarket, and, in an easterly direction, along Chandos-street to the Strand, intercepting in its course the Poland-street and St. Martin's-lane sewers. It is then to proceed along the Strand and Fleet-street, intercepting the Durham-yard sewer, the Somerset-gate sewer, and various other sewers passing down to the Thames. At Farringdon-street it is to pass over the river Fleet, and thence along Ludgate-hill, and, in an easterly direction parallel to the Thames, along Great Carter-street, Fish-street, Trinity-lane, Great St. Thomas Apostle, Cloak-lane, Cannon-street, Eastcheap, Little Eastcheap, and Tower-street, intercepting in its course the whole of the present sewers from the Holborn, Finsbury, and City districts. It is thence to pass through Trinity-square and along Postern-road, Rosemary-lane, Castle-street, New-road, and Brook-street, intercepting the sewers in the Tower Hamlets district as far as the end of Brook-street at the Commercial-road, from whence it is to proceed in a northerly direction through Stepney, and along the west side of the East London Cemetery, and thence along the Mile End-road into the main sewer, and near the river Lea navigation.

SECOND CLASS SEWER, B⁴ B.

This sewer will convey the drainage from Hackney, and will, together with the existing sewers, passing down the North-road, the South-gate-road, and the Queen's-road, and, intercepted by the main sewer, provide for the whole of the sewerage north of the river Thames.

The main sewer for the drainage of Westminster, and of the districts on the south side of the Thames (shown on the drawing Nos. 1 and 3, and marked D, E, F), is to commence at the outlet of King's Scholar's-pond sewer, from which it is to pass under the Thames, by means of a bent wrought-iron culvert, into the Lambeth district, and thence through Kennington-oval and Kennington-common, in an easterly direction to the Camberwell-road; it is thence to pass along the Black-ditch to the Kent-road, and thence in a south-easterly direction, under the Surrey-canal and the Croydon Railway, near King's-cross Station, and under the King-street-road at Deptford, and the river Ravensbourne, north of the Blackheath-road. It is thence to pass along the Greenwich-road, in front of the Greenwich Station, and across the south side of the Park, into the Bugsby Marshes, where the outlet into the Thames is to be formed. The total length of the main sewer will be seven miles four-and-a-half furlongs, and the average size about ten feet, with the exception of the two miles adjoining the outlet, which is to be fifteen feet diameter, and capable of containing 40,000,000 gallons, or the greatest quantity that can pass into it during the time of flood-tide. The enlarged portion of the sewer may also be made available for the disposal of the sewerage, for agricultural purposes, as described for the sewerage on the north side.

SECOND CLASS SEWER, D¹ D.

This sewer will collect the sewerage from the Kensington-canal sewer, the Ranelagh sewer, and the other sewers passing through Chelsea down to the Thames. It is to pass along Cheyne-walk, and along the slob of the Thames, on the site of the proposed embankment, and thence along Mr. Cubitt's wharf to the King's Scholar's-pond sewer.

SECOND CLASS SEWER, D² D.

This sewer will collect, in a similar way, the drainage from the sewers passing across Parliament-street, and Milbank-street, which it is to convey into the King's College-pond sewer, near its outlet. It may be afterwards extended (if required) along the slob of the Thames, so as to intercept the sewerage of the river frontage, between the outlet of the Fleet and the Northumberland-gate sewer.

SECOND CLASS SEWER, E¹ E.

This sewer will commence from the river Wandle, and proceed along the present sewer, until it joins the main sewer in South Lambeth, at letter E.

The district to be drained under the proposed system, lies altogether eastward of the river Wandle and the Kensington-canal. The towns westward of those boundaries are surrounded by agricultural districts, where the sewerage will be extremely valuable; and each should have an independent system of drainage into

the Thames, with outlets similar to those already described, and side reservoirs under ground, for the purpose of procuring solid manure, and filtering the water. The town of Woolwich, on the Charlton or west side, may be drained into the sewer on the Bugsby Marshes, and on the east side by a similar outlet in the Plumstead Marshes.

The proposed system has the following advantages:—

1st. Each of the proposed sewers may be provided with water from the Thames, or from the Regent's or Grand Junction Canals, in case a greater supply of water is not obtained for the Metropolis.

2nd. Each of the sewers has sufficient fall to ensure the complete natural drainage of the Metropolis, without the assistance of any machinery, and is arranged so as to combine with the present system of sewerage, upon which large sums have been expended.

3rd. It is constructed so as to admit of the sewerage passing into the river Thames during the first five hours of ebb-tide only, where it will be diluted with a vast body of water, and will pass to such a distance down the river, as to ensure its not returning near the Metropolis with the flood-tide.

4th. It is arranged so as to afford the greatest facilities for the disposal of the sewerage for agricultural purposes, either in a fluid state by pumping it along the Regent's-canal, the Grand Junction-canal, and the river Lea on the north side, and along the Kent Railway on the south side of the Thames; or as solid manure by the several railways and canals adjoining the depôts.

5th. The means afforded for collecting the sewerage, and making it available to any company who may desire to dispose of it, will not require any additional expenditure beyond what is necessary for providing a complete system of drainage for the Metropolis, and for its discharge at a distance of seven miles below London-bridge.

6th. The works may be executed within one year from their commencement; and the total cost of the sewers shown upon the plan, will not exceed £500,000, including all compensation.

(Signed)

J. B. M'CLEAN.

Mr. WILLIAM MEUBAY.

As a principle, three primary points are laid down to be attained, if possible, in connexion with this subject, viz. :—

1st. The preservation of the river from pollution :

2nd. To render available the present sewers by a more efficient discharge of their contents, thereby retaining the present outfalls, saving a great expense, and preventing the obstruction of the public thoroughfares for a protracted period :

3rd. To turn to a profitable use the sewage as manure.

To accomplish the first, two river sewers are proposed, one on each side of the river at the foot of the banks, extending from Chelsea and Nine Elms to below Plumstead Marshes; to be discharged by tidal means, and the outfalls of all the present sewers turned into them.

With regard to the second, the defect being probably not so much of construction as the want of regulated means to remove the vast accumulation of filth, they being at present dependent almost entirely on casual heavy showers to dislodge the immense deposit, from all sources, which in summer weather is a serious matter, taking into account that before the breaking out of the cholera this year, there had been no heavy rain for two months; it is proposed that a line of eight-inch cast-iron pipes should be laid down, encircling London on the north, from Limehouse to Paddington-basin, and the south or Surrey side, communicating with the sewers lying between them and the river; to facilitate their evacuation by a daily supply of water derived from the Regent's-canal on the one side, and the Grand Surrey-canal on the other, paying the proprietors of these a fixed annual sum; the water to be forced at each end by steam-engines for a given period daily. It is estimated that 4,000 tons of water from the Regent's-canal on the whole would not reduce it half an inch. A supply of 2,000 tons could be obtained from the Grand Surrey-canal, with a less apparent diminution.

Respecting the third point,—the sewage manure,—I have proposed to render its use more general, and consequently of more permanent value; to solidify it as much as possible; viz. : by the addition of lime, the properties of which are absorbent and valuable for land; also by a portion of the slimy deposit from the river. This would also render a valuable service to the river, which can never be in a healthy condition till it is removed. It is already used in many instances for light lands: as an illustration of its properties for one purpose, and of its unfitness to remain in the river, the landing-place at Nine Elms is remarkable,—the mud there on the

surface presents all the appearance of a stream of blood from a number of slaughter-houses ; on inquiry it has been ascertained to be myriads of blood-worms.

The plan proposes to carry the river sewers (below Plumstead) under the banks of the river into the marshes—fifty acres of excavated ground being laid out in dams on each side ; great facilities for the conversion into solid manure being here afforded, in the absence of habitations, and the locality being adjacent to the lime-making districts of Erith, Gravesend, and Purfleet ; having the assistance also of the Eastern Counties and North Kent Railways, as well for the lime as for transporting the solidified manure into the agricultural counties traversed by the Eastern Counties and North Kent and South Eastern Railways. The lime will also prevent any injurious effects to the surrounding atmosphere, which might otherwise occur.

Proposed—that the removal of the more solid manures and town sweepings should be confined to a company, being responsible for penetrating all the dense localities, and removing such collections by rail down to the manure dams. The inhabitants throwing refuse into the streets, or permitting collections of filth in yards and courts, to be fineable.

It may be added here, that in taking off any portion of the basin at Limehouse and Paddington, and those on the Surrey side, for the injecting of water, lime might be deposited when thought proper therein.

It will scarcely be urged that the sewage manure will be too much diluted even by the application of the quantities of water specified ; if so, so much the better for the inhabitants' health.

Being non-professional, this is submitted with much deference to the Honourable Members of the Commission.

(Signed)

WILLIAM MEUBAY,
Quarter-Master Serjeant, Royal Artillery.

15th October, 1849.

SAMUEL B. MILNE, ESQ., ENGINEER.

FIRST. The employment of covered sumpts, or tanks, placed at or near to the mouth of every sewer into which the more solid portions of the contents of the sewers are made to fall, by means of a particular form of sluice. These tanks are stationed at several other places along the line of sewer. After the solids are separated, the fluids are discharged into the bed of the river, under the surface of the low-water level. The separated solids are kept from being acted upon by the

atmospheric air, and thereby prevented, in a great measure, from producing the dissengagement of noxious gases.

Second. The employment of an effectual and ready means for lifting and transporting away the collected matters, without exposure or risk of producing any nuisance. The same means have already been effectively employed in several work-houses in Ireland.

Third. A method of producing a thorough ventilation in the sewers, at every part, and thereby draw off the gases as they are generated, which is a most important object to be obtained, in so far as it may entirely prevent the ascent of noxious vapours into the houses, arising either from imperfect trapping, or from permeation through the sewers and soil. Against these evils, there is no better remedy than a thorough ventilation of the sewers.

CAPTAIN W. S. MOORSOM.

My plan embraces the following main features :—

First. In principle—to provide main outfalls for receiving all the filth of the Metropolis, now poured into the river Thames.

To discharge all surplus sewage and drainage clear of any influence on the health or comfort of the Metropolis.

To do this without disturbing, to any material extent, the present outfalls.

To provide ample means of storage against times of heavy rain or flood.

To raise a revenue, by the operation of the plan, which shall relieve the public from all expense attending it.

To separate finally, and improve more immediately, the drainage of Southwark and Lambeth.

Secondly. In detail—to apply iron as a material in all cases where speed and exact work are required, so as to entail the least possible amount of inconvenience on the public.

To avoid all unnecessary interference with property by carrying on the works in tide-way.

To reduce the principal works to simple forms and positions, so that the whole becomes an aggregate of work of ordinary engineering character, capable of execution in nine months.

To form the several parts of the work so that they may be readily cleansed or repaired.

To arrange the design so that, if desired, a practical trial may be made of one or more portions, at a moderate expense, before entering upon the entire measure.

And it is obvious that the arrangement of the work enables the whole to receive tidal flushing without machinery.

(Signed)

W. S. MOORSOM.

17A, Great George-street, Westminster.

MESSRS. NASMYTH AND STATHAM.

18, Great George-street, Westminster,
10th October, 1849.

Sir,

IN accordance with the resolutions of the Commissioners, which we have received from you, we do not think that we can add anything to what we have already stated in our Report; viz., that our plan for the drainage of the south side of the Thames, possesses, in its main features, *economy, practicability, great facilities of execution*, no engineering difficulties of any kind, nor any interference with private or public rights, or property; and we are further convinced that it must recommend itself from its above qualities, as well as from its extreme simplicity. And we have again examined carefully our estimates, as delivered to you, which we are convinced are in every way ample for the purpose.

We have the honour to be, Sir,

Your obedient servants,

(Signed)

NASMYTH AND STATHAM.

E. H. Woolrich, Esq.,

Secretary to the Honourable Commissioners of Sewers.

ROBERT NETHERWAY, Esq.

My Lords and Gentlemen,

IN accordance with the wish of the Court, I have endeavoured to furnish as concise a statement as my scheme for the drainage of London and its environs will admit of.

The area proposed to be drained is eight miles in diameter from St. Paul's; which would have one main line of sewer, carried in a straight line from the end of the King's-road, Chelsea, to a point between Stratford and West Ham to the engine-house; it would cross the Thames twice in iron pipes, bedded in the bed of the river. At the engine-house the sewage would be pumped up from a depth of thirty-six feet, into iron pipes, which would be carried near the surface of the ground to the dépôt by the river Roding.

Tributary and intercepting sewers would be constructed where required, round the banks of the Thames, for receiving the sewage now taken into the river, and would discharge into the main line and the branch sewer at Rotherhithe. Those sewers would be four in number; one from London-bridge to the Greenland-dock, Rotherhithe, which would discharge into the branch sewer; and one from Battersea to the main sewer by Westminster-bridge.

On the north side of the Thames, a sewer would follow the bank of the river from the Houses of Parliament and London-bridge, discharging into the main sewer at each end. The other would be from between the East India Docks and the Tower, and discharge into the branch sewer at Limehouse. Reservoirs would be constructed, air tight, below the ground-line, for storing the water during the time of rain. This would complete the first part of the scheme, or it would suffice as a whole, but imperfectly.

The second is, by carrying additional lines to economise the engine power, and to *shorten* and *accelerate* the sewage in its passage to the engine-house. The first line would commence by the end of the New-road by the Bayswater-road, following in the New and City roads to Globe-town, when it would be taken in iron pipes near the surface along the low ground to the dépôt; another would be carried from the Kensington Gravel-pits, along the Uxbridge-road, Oxford-street, Holborn, and from there taken in the most convenient line to the New and City roads' sewer, in Old-street-road. Those two sewers would carry off nearly one-half of the drainage from the proposed area, and discharge at the dépôt from eighteen to twenty-five feet *above* Trinity datum. The other line would be from Kensington along Knightsbridge, St. James's-park, Strand, Fleet-street, and the Whitechapel and Mile-end roads to the engine-house, and discharge 17' 6'' below Trinity datum. (This sewer would dispense with the necessity of the sewer round the bank of the Thames from the Houses of Parliament to London-bridge.) The other additional sewers, on the Surrey side, would be a branch from the Rotherhithe sewer, crossing nearly in a straight line to Lambeth; and one from Hatcham, following in the Kent and Greenwich roads to the Rotherhithe branch by the Bricklayer's Arms' Station. The other would be carried in the Camberwell and the Walworth roads to the branch sewer by the Elephant and Castle. Sewers no doubt already exist in the greatest part of those

proposed lines, which would require the invert lowered only to gain the requisite fall.

The small towns and villages on the banks of the Thames, would be formed into systems independent of London, either separately or collectively as may be found most convenient. The sewage would be carried to a dépôt about three-quarters of a mile from the town in the lowest locality, where it would discharge into large tanks excluded from the atmosphere, and there precipitated, the refuse water flowing off through filtering drains, into the natural water-course of the country.

I am, my Lords and Gentlemen,

Your most obedient and very humble servant,

(Signed)

ROBERT NETHERWAY

To the Right Honourable and Honourable the Metropolitan
Commissioners of Sewers.

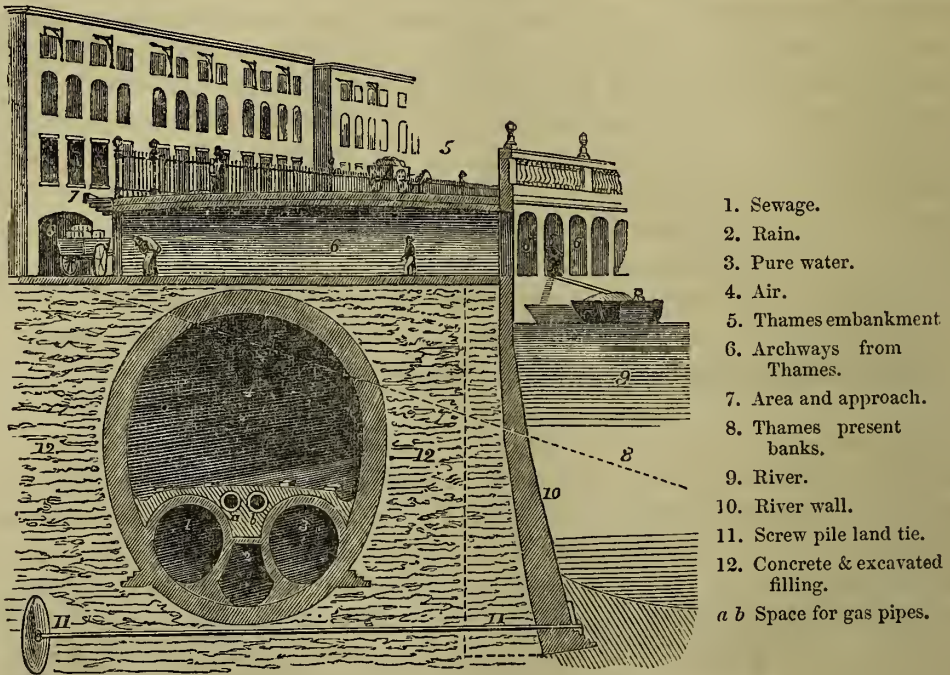
NUNC AUT NUNQUAM.

The novelty and magnitude of these plans may possibly cause, at first sight, objections which it will be impossible, in the present abstract, fully to answer; but, on investigation, it will be found that there are none of a serious or practical nature; but, on the contrary, many reasons in favour of their adoption. Indeed, one feature of these plans met, some years ago, with the approbation of some of our first mercantile and scientific authorities, and this would be the cheapest mode and time for such a work, as the combination of advantages would render it entirely reproductive. Bearing in mind the extensive powers of the Commissioners, and the opportunity which now exists, and which may not occur again for centuries, of improving the sanitary condition, as well as appearance and convenience, of the Metropolis, it has been deemed expedient to bring forward every improvement tending, in the slightest degree, to effect these objects. All improvements which may be effected collaterally are described as part of the plan, although they may be used separately, or in any desired combination; indeed, the system of sewage is complete in itself.

Three essentials being requisite for the maintenance of the public health,—viz., pure sewage, pure water, pure air,—it is proposed to form three tunnels within, and at the base of a fourth, still larger.

No. 1 is for Sewage. The rain is divided from the house water throughout its course, and, when coming near the Thames, is diverted into it; the other, or sewage side, being hermetically sealed. In case of accident, this can readily be opened by removing a flag. The superior tunnel creates sufficient depth to promote a clear outfall for the existing sewers; and, by lateral branches, as will be described, the

drainage of the low-lying districts will be greatly improved. The manure may be transmitted by air-tight barges in the existing canals, or by means of the railways, a



junction of which will, as hereafter described, be formed; it may be conveyed by manure trains, and in air-tight tanks, at a cheap rate, to distant parts of the country; or by water-carriage from the Thames, or by land carriage and carts, or for irrigation by engine power.

No. 2, *a rain sewer*, as above described.

No. 3, *Pure Water*. This will be supplied from the Wandle and other pure tributaries, or from the Thames, itself above the tidal influence and the locality of manufactures; or, what is probably very much better, from artesian wells, of which the chalk of the London basin would probably supply a number tenfold what would be requisite. It is unnecessary to allude to the deficiency and impurity of our present water supply. Ancient Rome received, according to her aqueducts 100 gallons per diem per person; and we might obtain an equal, if not greater, amount from beneath London without this expense.

Fountains might also be placed in different parts of the town, in the centre of wide and dangerous crossings and elsewhere, and in the vicinity of poor districts, where conveniences could be formed in connection therewith, cleansed by the surplus water, and surrounded by an ornamental screen.

With respect to the third essential, pure air, the large upper tunnel, No. 4, is intended to transmit any required amount into the heart of the Metropolis, from its termini in the suburbs and public parks, by means of fans worked by steam power. This air is meant to be emitted in the most impure and ill-ventilated neighbourhoods, near cemeteries, manufactories, &c., and into their chimnies, as has been publicly proposed; it would improve the draught, and bring down columns of fresh air by its own force of motion. As a matter of course, in stormy weather, such artificial purification would be little required, but even then the eddies of wind through streets and blocks of dwellings act much in the same manner on the impure and heavy gases, as oil stirred into water, forming lines and currents: the more impure bodies being carried into the lowest districts, as sufficiently evidenced in the recent epidemic; the poor vicinity of St. Giles was comparatively free, but the low-lying district of Lambeth suffered most severely from the scourge.

It must not be supposed that it is here meant to renew the entire atmosphere, although such might be effected without a very considerable expenditure of power; when we recollect that water, a less compressible, heavier, and more easily contaminated fluid, is conveyed to the mouth of every individual in this vast city; I merely seek to give to the often stagnant atmosphere impetus and free circulation. These currents of wholesome air, borne alongside of the pure water into London, will displace an equal column of foul air, it might be through the different rain-pipes of the houses, and the force with which they are expelled will bring from the atmosphere above a supply of oxygen to sustain the equilibrium, and which, coming thus vertically downwards, would search into courts and dwellings wherein a breath of untainted air has never yet entered.

There is also room for the laying of gas pipes at *a* and *b*, within the air tunnel, which will likewise form, at all times, an easy mode of access and of inspection for the sewers beneath.

This air conduit, No. 4, is intended also for a passenger tunnel,* as at Liverpool, commencing on the north west at Hyde-park, connecting the Great Western, North Western, London and York, Eastern Counties, Blackwall and Thames Haven Railways, and receiving the sewers in No. 1 on their junction with the Thames. Proceeding in the sound-deadening blue clay of the London basin, it passes down the river margin with a metropolitan terminus below the docks, the only legitimate outlet for the railways of England. This railway, being of short length, might be worked

* Should this part of the proposal be considered out of the proper sphere of the Commissioners, a Company, or probably one of the existing Companies, would readily take the lease and construction of such an undertaking, from the commercial advantages to be derived, and the facility of obtaining an Act of Parliament under the Government, and public approbation.

by atmospheric air, as at Dalkey. The southern railways to be united in the same manner, commencing at Nine Elms, and being connected by the Thames Tunnel, at present an unprofitable although stupendous work. *The same engines which work the railway would pump the water to supply London. Not merely would this tunnel have the railway traffic, but that of London itself, the greatest in the world, and undoubtedly sufficient to pay for the entire work;** and, moreover, the excavations would, at little or no cost, (less than that of cartage), form what has long been required, *an esplanade, or Thames embankment*, doing entirely away with the unwholesome and putrid banks and shoals, bare, more or less, during the greater part of the twenty-four hours. This alone is a sanitary consideration of the highest importance.

The operation of the system of sewage, irrespectively of the other features of the plan, is as follows :—

It is proposed, *in or near* the banks of the Thames, on the north and south side, to form two sewers at a sufficient depth to catch and carry off the existing sewage at any state of the tide. Such sewers are proposed to commence at Hampton on the north, and West Moulsey on the south, and carry the sewage through London, increasing in size as they proceed to the lower marshes, having modes for supply of manures by enlarged deposit receivers, at intervals, as required. There are also five lateral sewers, extending into and through the lower parts of the Metropolis, to relieve the low or table lands of those districts. At their outlet in the marshes, the sewage is sold for transportation by water or land-carriage, and the waste water, carried by an open cut to a sufficient distance below London, according to its amount of purity.

(Signed)

NUNC AUT NUNQUAM.

The more striking advantages of this undertaking may be briefly classed as follows :—

SEWERS.

1. The rain and sewage are separated throughout, and have a free outfall, except during floods, when the surplus rain passes through the overflow into the river.
2. The flat districts have trunk sewers, into which all existing or future drains, as well as the upland waters of the locality may run, thus giving great relief to the existing sewers.

* Passengers may get into the carriage at the level of the ground, and by a short incline be carried beneath to the general level of the tunnel, and by a rope, as formerly on the Blackwall Railway, a carriage might proceed from every station simultaneously.

3. The sewers are accessible without expense, effluvium, or inconvenience.

4. The sewage may be supplied at any required point, and wholly without leakage, by means of the railway; there will also be a small inclined approach for carts.

5. All the sewers will tend, as far as possible, by short separate lengths, to their terminal focus, thus effecting an ample fall, and obviating the necessity for a large sized pipe.

6. Being exactly beneath the air tunnel, they can always be kept free from dangerous accumulations of gases.

7. They will, from their amplitude and massiveness, suffice for ages to come.

PURE WATER.

8. Pure water may be conveyed to every house in London.

9. Public fountains may be formed in desirable situations.

PURE AIR.

10. The air tunnel will purify any required point of London, expelling the foul air from sewers, cesspools, or manufactories, and through the engine furnaces, or as described.

11. It is constructed so as to act also as a mode of public conveyance.

RAILWAY TUNNEL.

12. This railway will relieve the streets, and be an incalculable saving of time.

13. It will, moreover, in cases of the sewers becoming foul by silting up, be a cheap and expeditious mode of conveying away the deposits from any point in air tight tanks.

14. It would form an immediate approach, by man-holes, for inspection to the arterial pipes of London, whether water, gas, sewage, or rain.

15. It is the only admissible mode of conveying, by railway, the passenger traffic throughout London, as the house property alone, for a viaduct or a sunk line, would cost some millions sterling; and by quick inclined planes to the stations at

the surface, most of the objections to such tunnelling will be removed, particularly the interference with foundations, and the descent of shafts by passengers.

16. It will utilize the Thames Tunnel.

17. It will form a Metropolitan terminus and junction of all the railways.

18. It will not only pay for the entire work, but form, at little cost, the long projected work: the

THAMES EMBANKMENT.

19. This embankment will cover the impure and unsightly banks of the Thames.

20. New docks may be formed, and existing ones (for barges above bridge) arched across.

21. It allows of all the present operations of commerce, by means of transverse archways over the tunnel.

22. It gains ground, and improves the river from which it is obtained.

23. The ground of opposing parties once purchased up (until we adopt that course with the Thames embankment, very little will be done—I would rather see the river remain as it is, than any partial improvement effected), it could be re-sold at an augmented value.

24. It forms a new and magnificent street and healthy promenade, connecting, by a short route, the bridges and leading thoroughfares, Houses of Parliament, Somerset House, the Custom House, and, lastly, the Tower, near to each of which there will be stations for railway passengers.

25. This plan would wholly obviate the necessity of obstructing and cutting up thoroughfares, and avoid the consequent frequent settlement of foundations. The facility of underground access to the different pipes would not only be an economy, but likewise an advantage in every other point of view.

26. It would probably be one of the most remunerative works ever undertaken; and there is no reason why the leasing of the sewage and the railway should not pay all the expenses, and probably leave a balance to supply the poor with pure water at the fountains and stand pipes, or in their own dwellings, free of all rate or charge.

The great arteries of proposed Metropolitan communication are here combined.

There are no principles involved in these plans that our existing engineers have not given us successful examples of, under greater difficulties. The combination of works would surpass in utility and importance the cloacæ of ancient Rome, and it would become a monument of the skill and liberality of the present age.

(Signed)

NUNC AUT NUNQUAM.

LUKE FLOOD PAGE, Esq.

To the Metropolitan Commission of Sewers.

My Lords and Gentlemen,

IN compliance with your resolution of the 3rd instant, I beg to forward the following outline of my plan :—

1st. Preventing any more sewage going into the Thames (or any other river), not only at London, but in every other place, that now discharges its sewage into the river.

2nd. This to be effected in London by having a sewer on each side of the river, either to be tunnelled or worked from the surface in the silt of the river.

3rd. These sewers will either run from the extreme west end of London to the extreme east, in which case they will each have a mouth at their extreme east end, say in the Essex Marshes, and below Greenwich; or they will, beginning from Blackfriars-bridge, run east and west (see my plan), and then, besides the two mouths at the east, there would be two at the west. At these mouths there will be reservoirs, &c. and apparatus for supplying the neighbourhood with liquid manure, or for converting it into solid manure.

4th. Cleansing the rivers as completely as possible, by *convict* and other labour, from the filth that has been thrown into it.

5th. The Thames being cleansed in this way, would again be a source of health and pure air to the Metropolis; and an abundant supply of wholesome water could be obtained from it by water-works sufficient to furnish every part of London with that most necessary article.

6th. By having the sewers considerably lower than the river, the lowest parts of London will be thoroughly drained, and so will the cellars: and the various sewers

can then have a sufficient fall, which will prevent that accumulation of filth within them, which is now so productive of malaria.

7th. The surface drainage will be separate from the sewers, and carried into the river just above high-water mark: 1st, to prevent the malaria which escapes through the gully-holes; and 2nd, that the sewage may not be diluted more than is necessary for cleanliness. But as the sewers may occasionally require washing out, I propose that there should be a communication under ground between the surface drains and sewers, so that, when necessary, the rain-water may be turned into the sewers.

8th. A Central Board for sewers and drainage appointed by Government, under which all local boards and surveyors should act.

9th. An inspector for every district to be chosen by the district, to see that the sewers and drains of every house, &c. are properly constructed and kept in good order, so as to be no nuisance either to the inmates or neighbours.

10th. All nuisances and collections of filth to be removed from time to time, and the most suspicious places to be inspected as often as necessary.

11th. If it should be found necessary to give air to the sewers, lamp-posts should be put down and small iron pipes be carried up by their side, higher than the houses: the malaria at that height would be so diluted and dispersed as not to be a nuisance. Very few would consent to have such a pipe fastened to their houses.

12th. By embanking the river, the lower parts of London would be preserved from inundation, and the whole neighbourhood of the river would be preserved from the bad smell and unsightly appearance of the ooze; and a healthy promenade would be afforded to the Metropolis.

13th. The sewage, instead of contaminating our rivers, and propagating fever and pestilence, would be employed, as nature intended, in fertilizing our fields.

14th. Every house to have a convenience with water apparatus (cost about 30s.) at the expense of the landlord, and privies and cesspools to be done away.

15th. The surface drainage must be large enough to carry off easily the heavy falls of rain.

16th. Wells to be sunk, and pumps erected where wanted, at the expense of the parish.

17th. The cost of the sewers to be defrayed by a rate on all the property drained, or benefited by the drainage. The money for the construction of the sewers being borrowed, so as to be paid off in twenty or thirty years. The profit of the manure to be applied for the benefit of the property rated.

This is an outline of the plan I have submitted to your notice, and I refer you to the plan itself for the details.

I have the honour to be, my Lords and Gentlemen,
Your obedient servant,

(Signed)

LUKE FLOOD PAGE.

Woolpit, Suffolk, Oct. 10, 1849.

HENRY PHILLIPS, ESQ., ARCHITECT AND SURVEYOR.

5, Bermondsey Square,
October, 1849.

THE object of this inquiry I have assumed to be for the correction of evils now existing in the present sewers, as well as the best means of promoting the sanitary condition of the two millions of people inhabiting the districts under the jurisdiction of this Commission; I propose, therefore, to offer some observations, seriatim, from the final conduit up to the surface drainage.

THE OUTLET.

The first and chief point in all drainage is to find an efficient means of carrying off the soil and refuse-water, from the mouths of the sewers, into a receptacle sufficiently low as to drain the houses from the extreme boundaries of the several districts, and to disseminate this in the least prejudicial way; for this purpose an ebbing and flowing river is decidedly most beneficial. This is of especial importance in the suburbs of London, particularly on the south side of the river Thames, where the ground is very undulating, some parishes being very low on the surface of the roads,—for instance, Bermondsey, Rotherhithe, and St. George's (Southwark), which are on a level with the Trinity high-water mark. Many of the back streets and courts are even far below this elevation. In the parish of Newington the roads are two feet lower on the surface than high-water mark. Through these districts the main sewers now pass into the river Thames from the high grounds of distant parts, consequently those which are on the surface of the ground, below Trinity high-water mark, could not be drained below ground, but at particular periods of the tide, by means of deep sewers. All these low parts have to drain some distance from the river; therefore, it is essential, first, to have flood-gates to prevent the influx of the flowing tide; and, secondly, to have main sewers sufficiently capacious to contain the

back drainage, without flooding the houses in the vicinity of the outlets when the gates are closed. At times, during heavy rains, the rush of water is very great; and if this happen at a time when the flood-gates are closed against the tide, the houses in the low parts must be occasionally inundated. Bermondsey, Rotherhithe, Lambeth, and other places, have been occasionally visited by this annoyance;—even the river Effra, which is a sewer in the Brixton-road, has had the arch blown up by the pressure of water from the high grounds.

Having a knowledge of these facts, I am decidedly of opinion that all main sewers should be of a capacious size, particularly where any influx occurs, but more especially where the accumulation increases at the outlets into the river.

The appropriation of land to building purposes around London, and the rapid increase of houses, must eventually require new outlets to relieve the present main sewers, or the lower districts will be more annoyed than they now are.

OBJECTION TO THE TUNNEL PLAN.

When it is understood that immense quantities of refuse, filth, and water, are continually poured into the sewers from the fellmonger's yards, tanneries, dyers, hatters, and other manufactories on the south side of the river, it is plain that the plan of tunnelling is a scheme which, I believe, cannot answer, however low it be. The force of water is very great when it is concentrated by a violent stream from the high grounds, in a confined tunnel, entering it in opposition or in conflux, and must derange the concavity in the joints, whether it be of iron or brickwork. A passive stream might flow quiescently, but turbulent torrents, from high grounds, would derange the tunnel, and then the serious question is, how is it to be remedied without an outlet for the contents of the several sewers? Even if this plan were in any way practicable, and a plot of ground found sufficiently low to contain the immense quantities of filth which is continually passing into the sewers, would not this deposit create a pestilential pond, pouring forth its exhalations for miles around?

On these grounds I incline to the present mode of outlet into the river Thames from the north and the south sides.

Although many persons have complained of the filth which passes into the river, it is a well attested fact, that the Thames water lasts pure for a longer time than any other which is procured from other parts of the world, as is attested by all mariners: this may be attributed to the neutralization of poisons, which pass into the river, depositing the matter, or enabling it to pass away in the current of the ebbing tide.

I consider that many pernicious fluids might be beneficially prevented from an entry into the sewers, and save some of the pollution which now passes into the Thames; and I suggest that the mouths of the sewers should not discharge their contents on the margin of the river, which creates a deposit on the banks at low water, but that they should be carried from the flood-gates towards the current, nearer the centre of the stream, by which the sewer water would more freely pass away at the ebbing tide. There is another subject which is important to the health of the inhabitants, which, I apprehend, does not come under the surveillance of this Commission; I allude to the banks of the river. There are many mud banks on which the matter from the sewers is deposited at the ebbing of the tide, in addition to that which passes out of the mouths of the sewers as at present constructed. These deposits arise from eddies created by obstructions to the stream, forming spiral deposits of the matter contained in the water. These mud banks are particularly observable between Blackfriars and Westminster bridges, on the north shore. Were the river contracted at these places, navigation would not be impeded; the stream would pass more freely, and these mud deposits be prevented.

CONSTRUCTION OF THE SEWERS.

I do not propose to enter into a detail of particulars upon this subject, for the size and character of all sewers must necessarily vary according to their requirements. The capacity must be regulated by the back and branch supplies; but in all cases conical forms should be adopted, with concave smooth bottoms, as less likely to create deposits, and best calculated to pass off more freely the recipient contents. The present mode of sinking cesspools in sewers is the very means of forming poisonous deposits, and of obstructing the free passage of the matter received into them: the course of every sewer should be continuous and uninterrupted on to their final discharge. Not only is this an obstruction, but it is prejudicial also to the men who have occasion to enter the sewers; for gases from the accumulated filth in these cesspools are continually being disturbed, and emitting their poisonous gases to the injury of the men, as well as to the prejudice of the public health: not only so, but these cesspools require to be occasionally emptied, creating a pestilence in the neighbourhood, obstructing the public highways, and disturbing the pavements.

VENTILATION OF THE SEWERS.

Whilst the cesspools just mentioned remain, some ventilation is absolutely necessary; yet if this be abolished, as they ought to be, there will be an immense relief to the present pestiferous gases; yet, even if this important object be accomplished, still ventilation will be required, and the man-holes to be preserved, in order that the men may occasionally examine the sewers, as well as rake and cleanse them. This ventilation may be effected by the erection of obelisks, at convenient spots over the sewers, with glazed pipes inside of them, carried up sufficiently high as to dissi-

pate the foul gases into the upper air, to be carried off with the current above. If these be not sufficient, pipes might be passed up against the houses, at such an elevation that the exhalations may in like manner become innocuous. By this provision, the frequent opening of the present man-holes may be partially abandoned, and the traps opened only at such times as may be required to examine or cleanse the sewers, thus avoiding the public nuisances which now exist.

HOUSE DRAINAGE.

This part of the subject is one of great importance, but one of difficulty to give any specific opinion upon. Many of the houses in the low districts have the bottom floor lower than the sewer; others have no sewers near to the houses into which they can be drained; so that a universal drainage into the common sewers is absolutely impracticable. At the present time there are some of the deep sewers, towards their outlets, that are occasionally so full, that some of the houses are at times inundated from the back-water, when the flood-gates next the river are closed against the tide. With respect to those houses where there are sewers which are sufficiently low to take off the soil and waste water, no drains can be successfully applied, without there is an abundant supply of water at the head of the drains, which cannot always be obtained so copiously as to preserve the drainage clear; and in most of those houses where this is especially needed, the landlords will not be at the expense of providing it, nor of providing proper pans, cisterns, services, &c. If all these essential means for proper drainage were provided, I doubt, whether from negligence or a want of water, the drains would not be continually choked in houses where there are as many as six families in one occupation.

DRAIN PIPES.

Where there is a supply of water, and due care is taken, glazed pipes are the best sort of drains that can be adopted, if they be properly jointed, and laid to a sufficient declivity; but the size of these must be regulated according to circumstances. I consider that no pipe should be laid down of less size than three inches in the clear diameter.

SURFACE DRAINAGE.

This subject is particularly important to the health of the public, for the exhalations from the gully-holes cannot be avoided in passing through the streets; and those who are resident in the locality of them, cannot escape from the pestiferous smells which are now emitted from them. Indeed, it will be found that many of the fatal cases of cholera may be traced to these very spots.

The greatest portion of the thousands of gully-holes around London are now untrapped, and many are imperfectly trapped; so that the exhalations from

the deposits in them, and the smells emanating from the common sewers, pass freely up the gratings into the streets. Others that are trapped will, in dry weather, evaporate the fluid, and leave the dip-stone above the water, producing the same annoyance to the public as those which are untrapped. These gully-holes in low neighbourhoods are frequently used as receptacles for all kinds of filth; and even in the high streets, a certain quantity of foul matter is passed into them, forming a deposit in the cesspools, which, in dry weather, will emit those poisonous gases so detrimental to health. These gases are more attenuated in hot weather, and pass upwards; but as soon as the atmosphere becomes humid or cold, they are condensed, and descend to a breathing elevation, when they are more sensibly observed.

To remedy this evil, all the gully-holes around London should be properly trapped, and an occasional quantity of water injected into them, particularly in dry weather, so that the traps may be preserved in a perfect state. The infusion of this water will materially aid in flushing the main sewers, and may be as easily effected as sweeping the streets, simply requiring a hose to be affixed to those parts of the service-pipes where the plugs now are, from which the water may be directed into the several gully-holes in a very short time.

GENERAL REMARKS.

All the present open sewers should be enclosed, to prevent the accumulation of the evils arising from the putrid carcases of dead animals, decayed vegetables, and other things which generate the poisonous gases, and obstruct the free current. This is the more necessary, for when the open sewers are flushed, and the muddy bottoms of them disturbed, the ground beneath is left uneven, which tends rather to increase than to diminish the pestiferous evil. That the sewers require flushing at times, there can be no doubt, although this operation should be very cautiously regulated, so that it is performed at low-tide; otherwise, the houses in those parts near the river will be occasionally flooded, which has occurred several times in Bermondsey-street. In the present state of the gully-holes, the flushing disturbs the matter deposited, and throws off the gases through the gratings.

Were the drainage of London to be recommenced, some improved plan might be suggested; but such a mighty work would now be attended with great destruction of property, an incalculable annoyance, and a monstrous expense; therefore, the reformation of those sewers now in existence, is the best plan that I can suggest to the Commissioners, for the effectual drainage of the Metropolis. As regards the gully-holes, a better mode might be suggested; but this also would be attended with considerable expense, and a great disturbance of the pavements; therefore, the suggestions I have made with respect to the present ones, that all should be trapped, and water injected into them, may be considered to be the best and most economical plan to adopt.

I must not omit to allude to the turnpike roads. There are some of the roads in the district of this Commission that are drained into cesspools by the road-side, some having no sewers near, and others that are afforded this means of drainage, not availing themselves of it, as is the case with the New Cross Trust in the Kent-road. This is a great annoyance to the neighbourhood, consequent upon the occasional disturbance of the pavements to empty them; but also prejudicial to their health, from the stench which emanates from the soil.

I have, in a former communication, referred to the various boards of paving, lighting, &c., to which I respectfully refer the Commissioners; and in conclusion, beg to state, that the foregoing remarks emanate from a long experience of the localities of the Metropolis in various directions.

I have the honour to subscribe myself,

(Signed)

HENRY PHILLIPS.

HENRY PINKUS, Esq.

To the Right Honourable and Honourable the Metropolitan Commissioners of Sewers.

Gentlemen,

IN devising a plan to meet the known exigencies of the matter under your consideration, a concentrated view of the several prominent features of the case to be met, will lead to easier understanding of the method I have designed, and my reasons for adoption of the scheme to accomplish the desired end.

A comprehensive view of the whole subject requiring attention would appear to show, that the indispensable objects to be attained, if a thorough, not partial only, system of drainage and purification be contemplated, are,—

Firstly. The complete concentration, transposition, and adoption for profitable use of the suspended excrete, in the fluid sewage of London and its suburbs. To effect this without contaminating the atmosphere superincumbent to that of the sewers, and without annoyance to the inhabitants.

Secondly. The no less important object in a sanitary view, a method of completely ventilating the extensive subterraneous tunnels, in such a manner as to exclude contact with or mixing of their inoculating condensable vapours with the sustaining atmosphere, and which find ingress to, and contaminate the interior of houses and furniture.

Thirdly. Simultaneously, an imperative ventilation of the interior of buildings and their foundations, doubtless saturated with moist impurities, the accumulation of past

time, the natural courses of which are impeded by an almost interminable net work of foundation and sewer walls, through the latter of which the watery particles only can infiltrate, in a limited degree by capillary absorption, leaving suspended impurities behind.

Fourthly. The constant, changing transition and disinfection of the permanent inoculating gases of the sewers.

Fifthly. Such additional supply of water from the Thames as shall suffice for sewer and surface cleansing only.

DRAINAGE.

I humbly regard all these as a combination of objects intimately connected and undivisible, indispensable in provision for drainage in its full sense, apparently alone suitable to a Metropolis having such extensive covered surface; considering, too, the topographical position of London and its suburbs. The omission, therefore, of any of the foregoing conditions, would appear to leave a serious incompleteness, and an admitted, existing, vicious system would neither be neutralized nor cured. The objects may be attained by simple means, with less outlay for the combined objects, with comparatively smaller cost of maintenance, by adapting the present main and secondary sewers to the desired end, than would be the cost of continuing and maintaining the present partial system, by more extended application of the same, because the difficulties of the case begin from the moment of complete interception of the whole mass of sewage in any general receptacle.

REASONS FOR ADOPTING KIND OF SYSTEM.

There appears to be only two feasible means of getting rid of the sewage of large cities, and so situate as this Metropolis; either to disgorge into a river, or to absorb, transmit, use up, and render profitable.

The opinion that rivers are the natural and proper drains for towns, must be modified by the consideration of the contiguity to, or distance from an ocean, and by their uses. The Thames is not adaptable from any of these circumstances. If the latter plan be accepted, then there is necessity for careful arrangement for disposing of so large a mass of continually generating matter, to prevent excessive accumulation, and consequent danger of incurring malaria in the districts of deposit.

A means to extend the use of sewage in a fluid state for land irrigation is desirable, until the demand shall be equal to the supply. This is dependent on further agreement between agriculturalists as to the proper form in use, whether in solution or in solids. Adaptation of means thereupon, by both methods, is requisite

for safety in storing any excess in the latter form, and thus provide for wider market. An obvious objection, in the doubtless true method of use (the former) is, a constant *excess* in dilution, rendering it unfit for general use, except only in dry seasons; excessive and dangerous accumulations in that form would thereupon result in wet seasons, and during the ripening and getting in of the crops.

Again, disinfection in both forms, *before use*, appears to be indispensable; if not, such chemical change as shall render human fæces, with secreted diseases, innocuous, as well to the growing plant; as I humbly conceive, but in absence of correct knowledge, is possible, as the infant imbibes disease from the breast of an impure mother, or nurse.

Transition of sewage should be to depositories distant from dense populations, and diffused; such scattered depositories are the proper localities for manipulating, and disinfecting, for quick absorption, over wide districts, radiating from centres of generation.

VENTILATION.

Ventilation of sewer tunnels should be simultaneous with their drainage, and should be of a kind, that will at the same time give ventilation to buildings, and drainage to their foundations, by causing the atmospheric currents from them to find ingress to sewers, instead of thence to buildings, as is common.

ARRANGEMENT OF SYSTEM.

The general scheme is such, as that the outlay for plant and works for the attainment of all conditions for drainage, ventilation, transit of sewage for given extent of lead to scattered urban districts, is one outlay, not largely enhanced by provision also for additional water for sewer and surface cleansing only.

In the formation of this system, *the present main and supplementary sewers are adhered to* in combination with mechanical appliance, and in method of use.

In respect to the professional controversy; the capacities of main sewers are not in excess, considering extension of covered surfaces and increasing population, and because they may be contracted, as has been suggested, for present exigency, and speedily enlarged for future necessity. The present capacities are suitable for proper ventilation of buildings and foundations, and for flushing without contaminating the sustaining atmosphere.

The present injudicious process of entailing upon any one covered district the accumulated impurities of several, as those of the northern upon the southern, may be obviated.

In adopting thus one of two methods appearing to me, I have had in view, as a basis, speediest means of adapting present system of sewers, rendering them equal to the several objects sought to be effected, with the least outlay to that end, and, also, what in large public works should be always a primary consideration, adoption of system that, equally fulfilling requisite conditions, shall entail the least annual maintenance.

NATURE OF SYSTEM.

I avoid the Thames as a receptacle ; I adopt the Thames as one source for elementary power, and I adapt another elementary source as a contingent power.

My method will exhibit a converging and self-diffusing means, making present sewers subservient to that end, with slight alteration and expense, at local points, in depressed levels, and in arial divisions of surface.

The system is syphonic, effected by a combination of hydraulic and mechanical principles, in operation inducing constant local accumulation, transition, and diffusion, by radiating ways, through arterial tubes hermetically sealed.

The whole construction and means are extremely simple. The operation is self-acting ; the time is constant ; the combination with present sewers is speedy in application ; drainage and ventilation are simultaneous ; cleansing water supply is diurnal and intermitting.

The sewage flow is from points in arial divisions, radiating towards distinct urban districts, to avoid concentration in large masses, and, to scattered places, to expand the field for supply, and adopt convenient localities for converting into solid form surplus matter.

The motive forces for all objects are, by stream and reservoir mills, with a contingent power, to avoid expensive maintenance of numerous steam-engine establishments.

This elementary force is equal to any present or future extension to distance, for sewage flow for land irrigation.

SUBSTANCE OF PLAN.

In adapting the present sewers, I form the Metropolis and covered suburbs into general arial divisions and subdivisions. The general division will embrace the margins of the Thames as base lines ; (northwardly, ultimate coincident lines will embrace the covered surfaces of suburbs) ; intermediate lines, coincident with base, will form subdivisions.

The base lines conform to the course of the Thames.

The length of base lines may be about one half mile, taking in the main sewers verging to outfalls.

North of the Thames, on the termini of base lines, I raise parallel ascending lines, running northward and westerly, and northward, and northward and easterly, to ultimate lines, coincident with the basis of the square parallelogram or figure. These will form general divisions. The lines forming subdivisions running east and westerly will be ranged in ascending levels, say twenty-four feet elevation.

The sewage flow is from converged points in subdivisions, through general divisions, and through arterial tubes *from lower to higher levels*, and by way of best levels, to urban outlets in distant fields, or scattered depositories, for reduction.

The general arial divisions are formed by entrapping on the ascending parallel lines raised on base northwardly. The main and secondary sewers are entrapped by valves acting from surface, or by overflow walls, for temporary, not permanent, insertation. These will confine the sewage to the arial square, parallelogram or figure.

The subdivisions are formed by entrapping or overflow walls, as before, on the lines coincident with base and twenty-four feet elevation, so as to confine sewage in each subdivision, but may be made to communicate with other divisions by the valves or overflows.

The sewage streams in each subdivision converge to points of lowest depression; these will be found on the coincident lines of elevation. At those points subterraneous wells are formed by slightly depressing and enlarging main sewers. The wells may be, say ten by ten and fifty feet and insulated.

The distance between the coincident lines forming subdivisions will depend on attainable levels of twenty-four feet, without regard to distance.

The outfalls from these wells are thence through the arterial tubes; the exit is through general divisions to and beyond suburbs; south of Thames, the arrangement is similar.

COMBINATION OF ARTERIAL TUBES.

Through convenient ways, in the arial division, inclusive of base and ultimate coincident lines of suburb, I would lay successive sections, metal tubes of flow, say

twenty-inch diameter. The lengths of these sections determinable by the distance between the lines of subdivisions and their respective wells on the gradient of general division.

The tube may be laid above the crown of sewers, or in them, when compatible with planes, capacity, or otherwise; one end of tube will dip into well, of altitude and find outfall in the next well of elevation, but not dip.

Each well is furnished with a self-acting syphon valve, similar arrangement continues in next successive sections and subdivisions, inclusive of that division beginning in Thames and verging to its local suburb northwardly. The arrangement is the same in all general divisions.

Collateral with tubes of flow, and beginning with the first well on the Thames, I lay near the surface level a continuous feeding main, nine inches diameter. This may be laid in the same bed, or another, according to circumstance, but not in broken sections; these pass all the sections and wells, but communicating with the latter by syphon bends, having a separating valve, to be moved simultaneously with valve of well. Motion is produced by rise and fall of fluid in well. Intersecting valves are placed on the larger and smaller tubes, and intermediate pressure gauges are attached.

The outlets of two or more tubes of flow may be to general northern main, to lead to urban districts. The first series of wells are at outfalls on Thames.

Assuming the general division to be half a mile base line by two miles to suburb, then the lengths of tubing for each general division will be about 3520 yards, or two miles. This is the mechanical arrangement for each general division, assuming the covered surface north of Thames to be equal to seven miles by the course of the stream two miles northward. There would be fourteen square miles, fourteen general divisions, and as many radiating leads from centres of sewage generation to diffused urban districts.

Now through the longitudinal centre of the Metropolis, I lay, near to the surface level (without regard to inclinations), a ventricle main tube, eighteen inches diameter, passing, in continuous line, all the general divisions and communicating with all the smaller collateral tubes of those divisions, at either end or part of them; and I divide this continuous main into sections, by intervening valves, placed on either sides of general divisions, and I apply syphon wells at the feet of any declivities, to collect and pump off any water condensing from moist atmosphere, and, on and along the whole course of this main, I establish frequent gauge indicators.

The length of the main will be equal to the length of the curved surface, and its termini will be at the sources of the most distant motive forces, say ten miles, north and south of the Thames.

The ventricle tube is a feeding main of power to all the collateral tubes of divisions.

This concludes the whole mechanical appliances for plant, in combination with sewers, for the Metropolis and suburbs, for drainage, ventilation, and intermittingly, cleansing water for sewers.

For the retention of cleansing water, there may be subterranean reservoirs at the heads of divisions, say one for each or summit level, main sewers may be adapted to that end.

The motive forces act through the ventricle and its collateral tubes to give action to the arterial tubes of flow.

Two motive forces, stream and reservoir mills, to be established, the former by floating mills at ten convenient points along the Thames; the connexion is by chain-tubes, nine inches diameter, the latter, at places of facility, above and below bridges. The contingent auxiliary powers, at convenient stations.

The method of operation with this system, for the several objects, is described in the paper already submitted, and of which this is an abstract.

The system may be modified and varied, as before stated, and to suit localities consequent on topographical variations.

VENTILATION.

The man-holes and all vent gratings to be entrapped, by acting valves with gravity weights, to open for ingressing water and air, and self closing.

Transmission of the atmosphere of sewer-tunnels of divisions is given by the exhausting method at the heads of divisional areas, causing exit at the instance of the motive forces, through ejecting shafts, at points beyond suburbs, by the methods stated in the paper submitted, and, where disinfection of gases and condensable vapours may be effected by either of the processes therein suggested, thus effecting constant abstraction of mephitic gases from sewers, and inducing currents from interior of buildings to ingress to sewers, instead of the present convers-course, leaving the atmosphere of streets and buildings free from contamination.

FOUNDATION DRAINAGE OF BUILDINGS.

The system, as herein proposed, gives constant clearance and ventilation to sewers with currents ingressing to them; this admits of the insertion of drain tubes to foundations, through the side walls of main sewers, above ordinary streams of sewage flow, with self-acting arrangement for shutting off outlets of drain tubes, by any excessive rise of surface, from storm water.

The system proposed admits of quick application; a large portion of the Metropolis could be prepared in one year, and the whole in two years.

CLAIM.

I rely on—

1. The general arrangement.
2. The method of forming general and subdivisions of areas by entrapping sewers.
3. Combination of arterial tubes with main sewers and attached apparatus.
4. Further combination of main and collateral ventricle tubes and attached apparatus.
5. Method of forming aerial wells and their apparatus.
6. Method of working aerial plant.
7. Causing sewage flow from lower to higher levels.
8. Described method of diffusion to urban districts.
9. Method of combining and using elementary forces for any or combined objects.
10. Method of ventilating sewers and disposing of their noxious atmospheres.

I have the honour to be, Gentlemen,

Your obedient Servant,

(Signed)

HENRY PINKUS.

APPROXIMATION OF ESTIMATES.

Plant of Works.

	£.	£.
Assume—North of Thames 14 square miles }		
South of Thames 7 square miles }		210,683

Elementary Power.

Two sources.....	80,000	
Reservoirs works and lands	200,000	
	————	280,000
Investment for 21 square miles of }		
covered area }		£490,683
		————
Equal per areal mile	£23,366.	
	(Signed)	H. P.

MESSRS. EDM. AND WM. PONTIFEX.

Shoe-lane, October 13th, 1849.

Sir,

IN compliance with your request, I beg to forward you a concise statement of the main features of Messrs. Pontifex's project for improvements to the Metropolitan sewerage, and at the same time to direct attention to the description which accompanied their drawings, of which the following is a summary.

The present sewers of London are to remain as at present; but instead of discharging themselves into the Thames, it is proposed that large cesspools or sumpts be constructed at the present outlets, to receive the soil; these cesspools will be connected with a tunnel running under the bed of the river to a distance of ten or fifteen miles, for the purpose of carrying off the liquid drainage which may be used for irrigating by branches, various low lands in its passage.

The cesspools or sumpts, will have upper and lower divisions (see Plan No. 1), having sluice gates to separate them; at the top of these gates will be attached floats, by which means each tide will open them, and permit the sludge to run into the lower divisions, the upper divisions having shelving bottoms. In these lower divisions will be fixed machinery for raising the sludge into barges, which operation may be carried on without the rising of any noxious effluvia, and be attended with a very trifling amount of labour. The sludge, it is anticipated, will produce a large revenue by its sale, for agricultural purposes. With the view of cleansing and removing all obstructions from the sewers, sluices will be connected with each cesspool, so that at high tide a large flood of water would be admitted.

It is proposed to carry off the disengaged offensive gases, generated in the sewers, by pipes communicating therewith at numerous places. These pipes will meet at selected high points of the Metropolis, which it is proposed to divide into a certain number of compartments; the object of this division being to provide the most efficient means for carrying off the offensive gases. At these points, chimneys will be carried up to a much greater altitude than any of the surrounding buildings, and will be the grand vents for all the offensive gases in the several compartments of London. There would probably be twenty or thirty of these compartments and chimneys, but an accurate survey of the present sewers would ascertain the proper number. The gases, from their lightness, would readily pass into the pipes, and from thence into the chimneys; they may be made to pass through fire, but this is considered unnecessary, besides involving continual expense and attendance. In order to prevent any noxious effluvia arising from the gully-holes in the streets, it is proposed to have them effectually trapped, and likewise to stop all vents or other means of egress by which any effluvia might escape.

By this arrangement, the river would be unpolluted and perfectly fit for domestic uses; and it is proposed, that water-works be established to supply all poor neighbourhoods with water by means of water-posts, which may also be used for supplying water-carts to water London in dry weather, and to keep all the trapped gully-holes abundantly supplied.

A reference to the drawings will render the project at once intelligible.

Your obedient servant,

(Signed)

For EDM. AND WM. PONTIFEX,

JOSIAH HOULE.

To the Secretary of the Metropolitan Commission of Sewers.

WILLIAM RADLEY, Esq.

To the Honourable the Metropolitan Commission of Sewers.

My Lords and Gentlemen,

IN compliance with your resolution of the 3rd instant, that I should embody in another communication the programme of a method of civil and cloacal drainage, shadowed forth in the sixth, seventh, eighth, and ninth paragraphs of my communication, dated Switzerland, August 25, 1849, and published in No. 73 of the Records of your Commission, and reproduced below as a medium of referential comparison, I hasten to comply, as briefly as possible, with the same, reserving only that portion expletive of the particular method of defœcation recommended in this

system of cloacal drainage, and which, performed in one way or another, constitutes the objective origin and value of this particular system.

N.B. * * * * Here will come in about two pages of quotation.†

A careful perusal of these three paragraphs will show that a *double*, but properly connected system of cloacal and drainage conduits is intended, which I will now attempt to describe, merely premising that the application of this arrangement to the entire contoured area of the Metropolis is, by slightly varied repetitions of these details, of which they form the piecemeal exemplar, by whose multiplied association the whole system is to be completed.

Let us, for the sake of example, assume the line of Bridge-street and Farringdon-street, up to the Metropolitan confines, to the north, as the locus of a single instance of my arrangement, taking in an areal space, east and west, of about 440 yards, or less or more, according to the facility of acquiring cloacal outfall into the primary and secondary drainage culverts.

From the Thames-bank at, or considerably below, low-water mark, I begin a culvert, carrying it onwards to the northern boundary, with a rise of about five feet to the mile run, and diameter of four feet, preferably under the line of street. This culvert I denominate THE SECONDARY DRAINAGE CULVERT, and destine it to the conveyance of filtered sewage to the primary drainage culvert, or the grand fluviatile outfall in the river Thames, as the case may be.

This arrangement of secondary drainage culverts, will do well in ground of considerable elevation above the point of outfall, but conversely, as in the instance presented by the southerly locality under the line of Great Surrey-street, on to Brixton, a somewhat different arrangement would be requisite, but merely relating to the mode of outfall of the secondary drainage culvert, which, constructed at a level considerably below the river's bed, must *debouch* into a primary drainage culvert, running longitudinally with the river Thames, at a depth sufficient to allow the southern terminus of the secondary drainage culvert to be ten feet below the surface, to admit of the construction and adaptation, at an upper level, of the Sewers proper with their appendages. The Primary Drainage Culvert would thus take rise in the most westerly direction intended to be included in the Metropolitan sewage system, and following the river on both its banks, have outfalls at the most easterly point of drainage, ending at each terminus in a sump-hole and pit-shaft, provided with pumping gear and water-lifting engines.

† The two pages have not been forwarded to the Office. Nov. 5th.

When the secondary drainage culverts debouch into the tidal bed, a valved door must be appended to its mouth to prevent the ingress of muddy water, which, as we know from experience, would in a little time completely choke these conduits of otherwise desedimented sewage.

Attached to these secondary drainage culverts are a series of subterranean tanks, as recipients and stores of storm and imbral water-shed, whose overflow would be directly into the secondary drainage culverts, and their bases high enough to overhang the Filtering Beds of the Sewers proper, whose general purposes the sewage conduits now existing might subserve with, in many cases, but little alteration.

The sewers proper, traversing their loci with a proper dip, *transversely* to the Secondary Drainage System, would terminate at common points *upon* the Secondary System, in pairs of double, interchangeable filtering beds, so arranged that the defœcating and sewage-filtering process might be continuously

[*A gap here occurs in the original manuscript.*]

Mr. Austin's pretence, that a different system of sewerage should be applied to the low ground, to that which is devoted to the drainage of the elevated localities, falls as superfluous before the proposition of forming sewers, *tunnel like*, without disturbing the surface in all situations, where the solidity of the ground will admit of it; and such a method recommends itself to our notice, on account of the greater cheapness, which ought to obtain in its practical routine, over that of open cutting; and I dare venture to say, that in the generality of low situations, there is not the slightest necessity to resort to open cutting in cloacal construction.

Mr. Austin's method of district sumps, no doubt less liable to objection in ordinary and imbral drainage, is, in common with its whole class in the highest degree reprehensible, as "keeling and lading" within populous precincts an ever-fermenting and pestilence-breeding fluid, and its subsequent discharge into the Thames, within the regurgitating scope of its tidal influence.

As I have stated before, I have no objection to the river becoming the outfall of and recipient for the defœcated contents of a cloacal main, but I must never cease to inveigh against the converse of this proposition, nor refrain from the act of soliciting continuously for the consent of your Honourable Commission that this method of sewage outfall ought to meet with universal forbiddance and reprehension.

It is perfectly immaterial to me if Mr. Austin or others should say that "I have copied portions of their proposed methods of cloacal drainage into my own system herewith presented," because I write to your Honourable Board not for victorious

excellence of method, but to serve the common interests of mankind; and if the *all but* clearly developed method by insinuation given in the 73d number of the Records of your Honourable Commission be not sufficient to exonerate me from such an ignoble imputation, nor that of my assertion that the plan here proposed was written for, and offered to the Court of Sewers of the City of London five years ago, I must then rest contented with the joyful satisfaction that my proposition, being worth the cavil of able-minded men, some chance is offered of its being valuable to a degenerate and sickening population.

With regard to all those schemes in which iron largely enters as an adjunctive or essential component, as in competitor X. Y. Z., &c. &c. &c., at page 64 of your Records, No. 73, their utter futility will become apparent when we consider the high *mineralising* powers of sewage, exemplified in its capacity to convert iron, in the course of a very short time, into the fragile and easily disrupted form of SULPHURET OF IRON, not only in sewers, marsh and fen-land bogs, but when substratified anywhere, that animal or vegeto-animal matters abound.

As the task of criticising the propositions of others in this important regard is somewhat invidious, when the critic is himself a candidate for the disputed honours, I refrain, with these few observations, from pursuing this didactic investigation farther, and conclude by recommending the importance, in its antiseptic and commercial relations, of "The act of depriving sewage of its powers of becoming offensive, by the separation and removal of its filth, at suitable points of its progress," as infinitely more rational than its transmission into the Thames as now, or into grand eastern receptacles, even in the absence of its commercial advantages. The observations herein made, based upon a system of collateral and undeniable facts, show as well to the statesman as to all engaged in the progression of sanitary reform, how necessary to early, economical, and complete success it is that not only should all movements be made in common, but that able and well-informed minds should sedulously be enlisted in the cause, to the *exclusion of the appointees of mere patronage and interested partizanship*.

(Signed)

WILLIAM RADLEY, Ch. E.

Greenwich, Oct. 10th, 1849.

BARON A. B. VON RATHEN.

IN accordance with a resolution taken at the Court of the Metropolitan Sewers on the 3rd instant, of which I received due notice from the Secretary, Mr. Woolrych, I hereby respectfully submit to the examination of the Honourable the Metropolitan Commissioners of Sewers the following compendium and sketch of my plan and inventions, offered for the drainage of the Metropolis, by a memorial

and a large drawing, transmitted to their office, on the 29th September last. Any further order or communication with which I should be honoured, will reach me, addressed to the care of Messrs. Capes and Stuart, Solicitors, No. 1, Field-court, Gray's-inn. London, 17th October, 1849. Anthony Bernhard Von Rathen.

The objects which I had contemplated to attain by my improved system of sewerage, are, 1st.—To prevent manure flowing into the river Thames. 2nd.—To improve the existing sewers. 3rd.—To utilize the manure in carrying it out of town. 4th.—To prevent stagnation in the sewers, and the accumulation or exhalation of obnoxious gases.

The principal means by which I propose to attain those ends are: The erection of manure lifting and conveying stations, by which a permanent outfall in the sink, or sumpt, thereof is obtained. My claims of novelty therein are,—to raise the manure by the application of compressed air, which I have rendered cheap and practicable by my improvements in producing, conserving, expanding, and regulating compressed air. This invention is secured to me by two patents, obtained in 1841 and 1847. But the still more eminent invention I have considered it my duty, from sanitary and economical regards, to offer to the public, is the invention (not yet patented) of a new power engine, without fire, by which the half of the prime cost, and three-fourths in the current expenses for a steam engine, can be saved. To avoid all doubts on this great invention, I can offer in case as this, or a similar plan with lifting stations was adopted, to present a wealthy and highly respectable party as a guarantee for the success to contract for such lifting houses, and undertake the fitting and maintaining of the new power engine, at the said reduced costs. This same cheap and simple power engine could be also applied for evacuating the foul gases from the sewers, and providing cheaply the enormous quantities of water for flushing. The following sketch and explanation will serve further to illustrate my idea. Dimensions or proportions could not here be adopted; they depend entirely on local circumstances.—[*See original manuscript for Diagrams, &c.*]

Explanation of working the manure lifting apparatus. The sumpt or sink presents a considerable fall at the mouth of the sewer, and should be of great cubic capacity. The two openings, or locks, B, are alternately open, or closed, towards the sumpt; through the open one the manure enters into one of the iron vessels, A (squares or cylinders), which are alternately to be filled, to a certain height, in the sketch indicated by points. When the lock, B, is shut, compressed air is let in by the tube, D, by the pressure of which the manure is forced to ascend through the tube, C, into the cylindrical vessels or reservoir, F. When the manure has been thus forced out from the iron vessels, the compressed air tube, D, closes, and the lock, B, opens again towards the sumpt, as also the tube, E, to let the compressed air escape in the chimney. All those movements are self-acting; the practical way in which this can

be done is so well known to every engineer, that the author has only indicated the parts which are to be alternately open or closed. From the elevated reservoir the manure can be carried away by the tube, G, under ground, to another lifting station, or to a central sewer, or to garden and fields; or through the tube, H, into closed iron cylinders, fitted upon manure carts.

Proposed plan or system of sewers: It is evident, by means of those lifting stations, a permanent outfall of a voluntary depth can everywhere be created; and if such stations wanted to be erected in convenient places in town, they would be only intermediaire, as from the elevated reservoir a new powerful fall can be given to carry the manure further out of town to another lifting station, and then to the surrounding fields and gardens. The now existing sewers can easily be brought in communication with the new system, which consists in forming so many central or main sewers under the different high roads, and in directions indicated by the natural level of the locality, in manner to have the benefit of an incline out of town. For instance: To have a main sewer running out from the city in the direction from Finsbury-square, City-road, New-road, to Paddington, and there to enter into the sumpt of a large lifting station. The branch sewers of the cross streets to be conducted into the main sewer. Another central sewer might be directed in like manner from High Holborn, Oxford-street, to Bayswater, and its environs, where lifting stations could receive and carry the manure to the fields. Another from Piccadilly to Hammersmith, and its environs. Another from Houndsditch, White-chapel, &c., to Bow, &c. This may sufficiently explain my meaning. And of course this is only to serve as idea—as plan, the details and practical execution are left to the wisdom and experience of the Honourable Commissioners; yet I am prepared, if called for, to enter into further details about any difficulty in connecting the old sewers with this system; or to defend my plan against any objection. It would of course be contrary to my system to conduct any sewer from any village or place *into* the town, which could have no other object than to carry it out again; therefore, I propose that each village should have its own sewers, and manure lifting station, except it were already provided with one, as a receptacle for town manure. How the water could be separated from the manure in the lifting station, if desirable, is easily comprehended: by the specific gravity, the water standing uppermost could (even passing through a large filtering apparatus) be pumped out from the sumpt, and carried to the next canal or river.

Improvement of the branch sewers and the house drainage: The house drainage is already proposed, and carried through iron tubes to the branch sewer; but it remains to introduce, as a great improvement, iron tubes of larger dimensions, to form the branch sewers, instead of brick built ones. The great advantages of easing the current of manure, and preventing deposits and stoppage, are evident.

Lessons of wisdom to be deduced from the late explosion and fearful loss of life in the sewers, and proposed remedies: It is a known fact that those poisonous gases, in specie the sulphuretted hydrogen gases, are only produced in sewers without any fall, where the manure stands nearly on a dead level, decomposing itself, and forming deposits which still further impedes the current of manure. Providence has given us this lesson to obviate the horrible danger of a stoppage in an universal tunnel, or unique central sewer, the possibility of which, by accident, as, for instance, by an earthquake, or by breaking into it of the waters in time of inundation, &c., cannot be denied. What fearful plague would not this produce; it would drive every living soul out of town. My plan presents unfailing remedies against the formation and emission of such poisonous gases, which emanating from the old sewers may have favoured a great deal the spreading of the cholera. Because, 1st, my sewers will have a continued incline, causing a constant flow, without deposit and decomposition, with the assistance of discreet flushing. 2nd. A constant current of air can, and is proposed to be maintained by fitting up my cheap power engine from distance to distance. At the chimneys to be erected, to put large air evacuation pumps in motion, to suck the foul gases and air out, floating over the manure, and forcing it up through the chimney, by this creating a strong current, and atmospherical air will then forcibly enter the sewers at the gutters, which must be at all times open; and also by other openings at the river, made expressly for ventilation. No other kind of ventilation will ever fully succeed, by the fact, that those foul gases will not ascend, their specific gravity, especially that of sulphuretted hydrogen gas, being greater than that of the atmospherical air. By my system, having perhaps a hundred central sewers, and all of a very moderate practicable depth, any momentary stoppage by accident can never be of such fearful consequences, as with an unique tunnel, and can much more easily be remedied.

(Signed)

ANTHONY BERNHARD VON RATHEN.

London, 17th October, 1849.

J. BALDRY REDMAN, Esq.

5, New Palace-yard, Westminster,
8th Oct., 1849.

PRECIS OF SUPPLEMENTARY REPORT.

1. Assuming that the principles of improvement are as yet unacknowledged, the data furnished are scanty and insufficient, and it is absolutely necessary they should be more elaborate and extended, including the Metropolitan environs as per annexed plan, before any comprehensive conclusion can be arrived at on the general question: it appears impracticable to lay down a definite plan before the completion and publication of the Ordnance Metropolitan survey, with levels of roads, streets, sewers,

navigations, railways, estates, farms, parks, commons, and all enclosed or unenclosed lands, whether built on or not, with a view to provision for the increase of the Metropolis and its environs.

2. The contoured lines of levels should be so comprehensive and extensive and the borings so numerous, and on, say, every square mile of the map, that it might be possible therefrom to construct a model showing the superficies of London and also the subterranean geological formation, the same as for mining operations, in order to test the various proposed plans.

3. That borings should not be on any defined line, but over the surface, and might be increased by collections in the possession of the Institution of Civil Engineers, of the Geological and other societies, of public companies, manufacturers, professional men, &c.

4. That the lines and levels of all existing sewers should be distinctly shown before it is possible to attempt the detailed development of any plan for a new system of drainage; the improvement and extension of that existing, or any combination of the two modes.

5. That neither the time allowed or data supplied, warrant the attempt to define with exactitude particular forms, dimension, or expense; that it was considered best to abstain therefrom in toto, until the possibility of working with more certainty was arrived at; that the Honourable Commission will see the necessity of further postponing the inquiry on the various above grounds.

6. That the results of the Ordnance Metropolitan survey may show the necessity of abandoning or modifying certain portions of the following proposed plan. (Vide annexed plan.)

7. *North-west, north, and north-east* portions, bounded south by the Harrow and Edgware roads, Oxford-street, Holborn, Gray's Inn-lane to Exmouth-street, Skinner, Percival, Goswell, and Old streets, Old-street-road, Hoxton and Hackney roads, and Victoria-park: An initial vertical shaft at end of Lisson-grove, north; invert thereof eighty feet above datum, draining St. John's-wood and the squares and streets to Oxford-street; main sewer of discharge along New-road, falling ten foot in the first mile, seventy feet above datum opposite Fitzroy-square, receiving Kentish-town and intermediate district drainage, and the south to Oxford-street by Portland-place, Tottenham Court-road, &c.; twenty feet fall in next mile, and fifty feet above datum at Battle-bridge, sufficiently low for district north and south. One foot fall in the succeeding mile along the New-road, leaving the latter at River-terrace, under New-river and Regents'-canal, forty-nine

feet above datum, sufficiently low for neighbourhood of Old-street-road, to Beauvoir-square Beauvoir New-town, Islington; forty feet above datum; across Church-street, Hackney, west of which at five miles from commencement, thirty-five feet above datum; between Lower Clapton and Homerton, by a duct across the Hackney-marshes, over London Water-works, Hackney-cut, and discharging into reservoirs in the Hackney-marshes; channels north, south, and east, leading away to Leyton and Waltham-marshes, &c.; surplus brought south into Westham Abbey-marshes; residuum eventually led into Barking or eastern outfall—no communication with the River Lea.

8. *East part.*—Initial shaft at St. Paul's, at end of St. Martin's-le-Grand; invert level with datum; sewer of discharge, along Cheapside, Poultry, Cornhill, Leadenhall-street, Aldgate, Great and Little Alie streets, Church-lane, Whitechapel, Commercial and East India Dock roads, under river Lea, south side of Barking-road, through Plaistow and East Ham levels, under river Roding, and discharging into reservoirs in Barking-level, receiving also Barking drainage; reservoirs, also, in Plaistow and East Ham levels; main outfall, nine feet below datum, or twenty-one feet six inches below Trinity standard, and say, fourteen feet below marsh-level: drainage might occasionally stand ten feet in reservoirs, leaving an inconsiderable lift for distribution along Dagenham, Hornchurch, Rainham, Thurrock and Tilbury Marshes; south boundary formed by river Thames; and north boundary, Sir George Duckett's Canal, south-west side of Victoria-park, Hackney and Hoxton roads, Old-street, Goswell, Perceval, Skinner and Exmouth streets, Gray's Inn-lane, thence by Holborn to Drury-lane, which would form west boundary.

9. *West part.*—Initial shaft, at Storey's-gate; invert, level with datum; receiving drainage of east part of Westminster, Whitehall, and Strand to Somerset-house; main drain of discharge, along Birdcage-walk, south of Palace-garden, along King's-road, by Chelsea Royal Military Asylum; westward, by College-place and Bond-street, crossing York-place, south of Consumption Hospital, by Earl's-court, to Broadway, Hammersmith, at Cornwall-road, along King-street, through Turnham-green, west of which crossing Brentford-road; discharging westward into a reservoir between Ealing and Brentford—in ground, say twenty feet above datum; after eight miles course, eight feet below datum; drainage occasionally standing twenty feet in reservoir; passing the Brent westward, discharge drains would conduct surplus over district between Norwood and Hounslow, and neighbourhood of Cranford, Hatton, Bedfont, Feltham, Hanworth, Staines, &c.; also, by Isleworth to Twickenham, Hampton, &c.; east boundary, Drury-lane; north boundary, Holborn, Oxford-street, Edgeware and Harrow roads; south boundary, the Thames; west boundary, the Brent.

10. *South-east part.*—Vertical initial shaft at Elephant and Castle—invert, level with datum; drainage of Lambeth, Newington, Southwark and Bermondsey, con-

verging into it; sewer, or drain of discharge, by New Kent-road; a shaft at Brick-layer's Arms; receiving drainage, by Great Dover-street, Bermondsey-street, New-road, &c.; main drain, along Kent-road; collateral feeders at East-lane, Grange and Albany roads, draining Bermondsey, &c., up to Surrey-docks and Canal, and low parts of Camberwell, under Grand Surrey-canal, parts of Camberwell, Dulwich, &c., and all Peckham, draining by Commercial-road, Peckham-road and High-street, and by Deptford-road; leave New Kent-road, near New Cross, under the railways and river Ravensbourne, through Greenwich by Nelson-street and Trafalgar-road, north side of workhouse and Greenwich-road, along low part of Woolwich: receiving the whole drainage of that town where invert would be twenty feet below Trinity standard, and terminate in a reservoir in the centre of Plumstead-marshes—eventual distribution to Erith, Crayford, and Dartford Marshes.

11. *South-west part.*—North-east boundary, Harleyford-road, Kennington-oval, and Brixton-road; initial vertical shaft (invert level with datum), in Battersea New-town, east side of the park, receiving drainage eastward between the Thames and Clapham-road to Kennington-oval, and the lower part of Clapham to the south; drain of discharge, proceeding westward between Battersea and Battersea-rise, receiving neighbouring drainage and elevated parts of Clapham, &c., by Battersea-rise, under the Wandle; south, through Wandsworth, across High-street at lowest point opposite Church-road, receiving drainage of the town east and west; south, along the vale of the Wandle; reservoir, half a mile south of Summer's-town, and five miles from initial shaft, five feet below datum; a main by Wandsworth-lane would receive drainage of Putney, Barnes, and Mortlake—Sheen and Richmond by a separate arrangement.

12. *Surrounding Outskirts.*—On the north-east side, Walthamstow, Chingford, &c.; on the east side of the river Lea and Stamford-hill, Tottenham, Edmonton, Enfield, &c.; on the west side of the Lea, might, as the system was developed and extended, be drained into the vale of that river, and made to irrigate the bordering low lands; surplus carried south into outfalls before described. On the north, the western portions of Tottenham, Hornsey; the north of Stoke Newington and Upper Holloway, and the north-east part of Highgate, might, perhaps, be led away north, along the district adjoining the New River. On the north-west of Highgate and Hampstead, West-end, Cricklewood, &c., when that district becomes more built over and should require it, might be drained possibly to the north-west, into the Brent, in the neighbourhood of Kingsbury, and to the westward would be an extensive field for use of drainage detritus. To the south-west, Kingston, &c., might be similarly treated. To the south, Mitcham, Croydon, Sydenham, &c., might all have independent systems; also to the south-east, Beckenham, Bromley, Eltham, Chislehurst, Foot's Cray, Dartford, &c.

13. The economical working of the proposed west and south-west outfalls, will

depend altogether upon the results of the Ordnance Metropolitan survey; as also the eventual distribution of the drainage detritus.

14. Two sets of reception, transfer, and distribution reservoirs, are proposed at each outfall and of apparatus; the drainage to be turned into one or the other for periodical inspection, so that the distribution of the drainage should not depend on one set of apparatus—the reception reservoir to be lower than the outfall, and occasionally pumped dry.

15. It is apparent, that supposing the above proposed west and south-west outfalls be eventually abandoned, the whole drainage of London may be turned eastward, and by taking advantage of the fall of water at low water, carried into the Thames by a natural system of drainage effected by gravity alone, and small pumps and apparatus be used only for raising the more viscid accumulations after those that have been strained or refined by settlement, are allowed to flow into the river.

(Signed)

J. BALDRY REDMAN.

GEORGE REMINGTON, Esq., C.E.

To the Chairman and Commissioners of the Metropolitan Sewers.

My Lords and Gentlemen,

THE following is a concise statement of the original plan of Mr. George Remington, projected and described in the year 1825, a copy of which I have already transmitted to your Honourable Board:—

First—To construct an independent main sewer, of capacious proportions, on both sides of the Thames, and as near thereto as possible:

Secondly—That the said sewers should begin as far westward as may be found advisable, and that they should be continued—the one to the marshes below Plaistow, the other to the marshes below Greenwich; the bottom or sills of both sewers at the outfalls being level, or below the level of low-water mark, with a gradual ascent up the river to the highest point of drainage:

Thirdly—For the Isle of Dogs, Smithfield, and other markets, and certain other districts, to construct other minor main sewers as collateral branches to the leading mains.

Fourthly—At the eastern extremity of the principal main to provide large reservoirs and suitable machinery for lifting, and space for drying, the manure;

together with docks, basins, and other conveniences, and the same on the south side of the river.

Fifthly—At the western extremity, and at other convenient places, to provide reservoirs, to be supplied by the tides or otherwise, for the purpose of driving the sediment or manure to the eastern extremities, and for the purpose of cleansing the main sewers.

Sixthly—To construct a complete system of pipes, air pipes, drains, tanks, or reservoirs, for the purpose of collecting the lees, and other valuable liquid manure, from the houses, kitchens, &c. &c. &c.

And further I beg to observe, mention being made of collateral branch sewers from the leading or main sewers, that by these means the manure and other polluting matter which now falls into the Ravensbourne may be collected, by extending sewers along the opposite banks up to its summit, and the water of that river restored to its primitive state of purity, and converted to the supply of London. A similar system of sewers may also be carried up the Wandle and Lea, and the water of these rivers restored,—thus an almost unlimited supply may be obtained without injury to any interest, and without abstracting water to the injury of the Thames navigation, which latter may also be considerably improved, the great shoals of mud removed, and at the same time a quay and parade formed, extending from Fulham to Southwark, and the same on the south side of the river.

The supply of a sufficient quantity of wholesome water is indispensable; the rivers are its natural channels, but these have become polluted by the excrescences which are continually pouring into them from the various thickly populated towns and districts which have been raised upon their banks; but if conveyed away by other independent channels, the river water would be left as clear, bright, and wholesome, as when it first springs from the fountain head; therefore this plan embraces all that is required, not only in London, but all other towns in the kingdom.

I am,

My Lords and Gentlemen,

Your most obedient,

(Signed)

GEORGE REMINGTON,

11, Shaftesbury Crescent, Pimlico,

October 12th, 1849.

To E. H. Woolrych, Esq.

FREEMAN ROE, Esq.

70, Strand, September, 1849.

My Lords and Gentlemen,

SINCE I sent in my propositions for the drainage of London, I have re-considered the matter, and am led to think that some plan more inexpensive

than that of making a sewer all along the river, might be adopted. It is true, that without such a sewer some of the soil will escape into the river, but by the plan I propose that quantity would be very small, and would be delivered at low-water mark generally, instead of, as at present, running down the whole length of the shore exposed at low-water. Under any circumstances the surplus water must go into the River, whether pumped into it at the Isle of Dogs, or let to go into it at each of the sewers, and the tide by its ebb and flow, will, in both cases, distribute such water. My plan would get rid almost entirely of the mud bank, and would prevent much overflow of stinking water.

I propose, then, at the mouth of each sewer to put a large cesspool (or where two or more sewers come together, one cesspool for two or three sewers), to be sunk below the river, and to be proportioned to the size of the sewers; into this cesspool I would take the sewers in such a way as that the top of the mouth of the present or inlet sewers, should be a foot lower than the bottom of the exit sewer; the action then would be, that the soil and water would come down the present sewer into the cesspool, and as the mouth of the inlet sewer would be below that of the outlet sewer, the water, if the cesspool became full, would back up into the inlet sewer, and thereby prevent any wash, and allow the soil more time and opportunity to settle; and when the overflow took place, the surface water would run out by the sewer provided, which is extended nearly to low-water mark, and is finished with a tide valve; this provides an exit at low-water, while should the amount of drainage coming down at other times be more than the cesspools will hold, I proposed to put a cast iron pipe upon the top of the cesspool carried above high-water mark, with hanging valves, which would allow the water to escape at different heights, according to the tide, and through these valves the cesspools can be emptied, and their contents carried away into the country in the manner proposed in my former plan (by pumping into barges.)

In the cesspools I should deodorize the surplus water, before letting it run into the Thames.

Ventilation of the sewers, if thought necessary, may be effected by putting shafts in the most convenient places against the shore walls, either over the cesspools, or the sewers.

The drawings Nos. 1 and 2, on the sheet sent herewith, will help to explain what I propose.

The Drawing No. 3, shows an improved trap for streets. I cannot see how traps can be done away with, without a complete new arrangement and construction of the sewers, and therefore I have turned my attention to the best form of trap.

The difference between my former proposition and this is, that I now propose to do away with the expense of the large sewer, and the works at the termination thereof.

(Signed)

FREEMAN ROE AND HANSON,
Hydraulic Engineers,
70, Strand, and Southwark Iron Works.

M. L. SALTER, Esq.

To the Right Honourable and Honourable the Metropolitan Commissioners of Sewers.

My Lords and Gentlemen,

The main features of the plan submitted September 25th, (which, for want of a better title, may be designated for the present as the **RISEING-SHAFT SEWERS**), consists of several series of shafts; each one beginning a series to be sunk a little below the main sewer of a given locality. It would also vary in depth, with the variation of the surface-ground above. Thus, the **SHAFT-SEWER** would *rise* with every *rising* ground, and accommodate itself for a new course and inclination, exactly in accordance with its locality.

But the most important feature of this plan, consists in the frequent elevation, in brickwork, of the pump-tube of a given shaft, so far above the ground, or so much higher than the next shaft or shafts, that the sewage can be made to rise in them to a sufficient height, without any need of the use of pumps and engines, and the sewage be thus conducted from shaft to shaft. A column of air being admitted from time to time into the head of the higher sewer, would cause the sewage to *rise* in the next *shaft* or *shafts*, which are at a lower level.

It will be understood, that the depth of each shaft will be adapted to the outfall which precedes it; but that the shaft will *rise*, in brickwork, as much above the surface as may be required by the nature of the ground above, and by the extent or character of the line of sewer which succeeds it. (*See diagrams in original manuscripts.*)

The effluvia from the opening to admit the necessary column of air, to be met and defeated by strong jets of gas, or other provision of fire.

I forbear, for obvious reasons, to enter into any details at present.

I have the honour to be,

My Lords and Gentlemen,

Your obedient Servant,

(Signed)

M. L. SALTER.

At C. Mitchell's, Red Lion Court, Fleet-street,

Oct. 13, 1849.

N. SCOTT, Esq.

To the Honourable Commissioners of Sewers.

36, Clipstone Street, St. Marylebone.

PLAN as per model sent in 21st of August, viz., by laying down two tubular iron sewers, close to the shore, on each side of the Thames, from Richmond to Plumstead on one side, and from Twickenham to Plaistow on the other; and by using the same plan in all the rivers and creeks, and connecting them with the main sewer, as laid down on each side of the Thames, all the places as mentioned in Mr. Phillips's plan will be included in the drainage.

To have three receivers on each side, to hold the sewage, at Plumstead and Plaistow; the first one to filter into the other two, and the last one of each side would contain almost pure water, that can run off where it would not affect the river, or it could be profitably employed.

That the advantages of this plan would be, that the existing sewers having a fall towards the Thames, they will not require any alteration to connect them with the main sewer.

The main sewer could be flushed at high-water at Richmond, or Twickenham, or any other place on the main sewer, from the Thames, without polluting the river the least.

The main sewer could be repaired at low-water; and while the sewer was being laid down, it would not prevent the free navigation of the Thames; and all the refuse from the manufactories on the banks of the river could be conveyed to them direct.

This plan would not require the aid of any steam power, as the sewage at the depôts would be sufficiently high for its transport to any place requiring it as manure.

The cost of constructing the main sewers on each side of the Thames,	£288,000
For building the depôts at Plumstead and Plaistow	10,000
Total	<u>£298,000</u>

(Signed) N. SCOTT.

N.B.—The main sewer could be extended above Twickenham, and below Plumstead, with the same effect; and the above plan could be completed in less than a year.

HENRY E. SCOTT, Esq., C.E.

IN determining upon an improved system of drainage, I have considered it essential to bear in mind its chemical effects upon the health of the population. "An animal substance, in a state of decomposition, can excite a diseased action in the bodies of healthy [persons]." And "the origin of epidemic diseases, is often to be traced to the putrefaction of large quantities of animal and vegetable matters." Liebig furthermore shows that fresh fæces and urine have not the property of exciting fermentation or putrefaction, in other substances, prone to change, till after they themselves have passed into that state, and they do not ferment or putrefy, till they have absorbed a sufficient quantity of oxygen, by exposure to the air. Any collection of these matters, in tunnels, cesspools, or other receptacles, is to be avoided, so as to reduce their opportunities for fermentation. On the contrary, their removal must be rapid, immediately after their deposit, before they can assume a state to excite decomposition, in such other bodies they may come in contact with, during their progress to their ultimate destination, the sea. This removal can best be effected by water sufficient in volume and velocity.

London, on the north side of the Thames, is of such an elevation that the main sewers can be laid, at such an uniform inclination, as to produce a current through them, sufficient for a moderate quantity of water to carry off all deposits. If Mr. Robert Stephenson's suggestions, to supply this portion of London with water, were carried out (see his Report to the London and Westminster Water Company in 1840,) a volume of excellent spring water would be obtained, sufficient, not only for domestic purposes, but also for drainage. My attention, however, has been directed to the drainage of the Metropolis, on the south side of the Thames, where the deadly effects of the cholera have been chiefly experienced. This district is very flat, or rather there is a declivity *from* the river, for about a mile, towards the great Surrey canal, and the surface is generally *below* the level of Trinity high water mark. The inclination, which can be given to the main sewers on the south, must therefore be less, than in the district on the north side of the Thames.

The objects in the system of drainage which I propose are:—

1. To overcome the difficulty in level, on the south side of the Thames;
2. To reduce the chance of miasmatic exhalations to poison the air;
3. To prevent the liquid in the sewers from filtering into wells;
4. To reduce the existing injury to the river, from the sewers pouring into it.

I effect the first object, by causing the water of the Thames, when at high tide, to flow through the main sewers into a covered reservoir, constructed in a central situation. At low tide, I create another current in the sewers, by emptying the reservoir into the Thames by another sewer sufficient for the purpose.

The first mentioned or induction main sewers would be about half a mile apart from each other, and each must be laid at an uniform inclination (about 1 in 500) from the river, commencing at a level a little below high water at neap tides, and terminating at the bottom of the reservoir, the level of which must be about a couple of feet above low water at the lowest tides.

The second mentioned or eduction sewer (there being only one from each reservoir), must commence at the bottom of the reservoir, and terminate at the nearest point of the river, at the lowest level of the tide.

I propose there shall be two reservoirs for these sewers, one near the Surrey Zoological Gardens, the other near the Greenwich and Albany roads; so as to avoid the necessity of having very long main sewers. At each reservoir all the above sewers should have sluices, so that the communication with the river, may be shut or opened when required, and which could easily be done by only one man at each reservoir.

I propose that the above sewers shall be cast iron pipes with water-tight joints. I have calculated their size, and that of the reservoirs, by Dr. Young's formula; so that the reservoirs may be filled in an hour, and discharged in about a quarter of an hour.

I effect the second object, viz., the prevention of miasma, First, by having two sets of drain pipes, the one for impurities, the other to receive and carry off such rain as may fall on the roadway and footpaths only of the streets. There would, therefore, be no communication with the open air between the sewers and the gutter gratings, as the gratings would communicate only with the mains for rain water. Secondly, the reservoir for the main sewers being arched over, the air in them would be forced, by the rising of the water, through a flue, and thence through a fire in a small furnace constructed for the purpose. Thirdly, the air from the sewers would be prevented from passing up the sinks and waterclosets, by valves or traps of a suitable construction, but an escape pipe might lead from each house drain up a chimney.

The mains for rain water would be cast iron pipes of a suitable size, and would be placed by the side of the sewers, in the centre of the streets, and would have to terminate in a separate reservoir, constructed by the side of each of the reservoirs

intended for the sewers. When required, the rain water may be emptied from one reservoir into the other, by opening pipes communicating with both by means of a sluice.

The street sewers and rain water drains would communicate with the main sewers and mains, by an uniform inclination of at least 1 in 500, the means of doing so being quite as practicable in the lowest districts, as in those that are more elevated, in consequence of the main sewers being laid at a lower level, the nearer they approach the reservoirs. Change in the direction of the sewers and drains would have to be effected by easy curves.

All the sinks and water closets must be fixed above Trinity high water mark, so as to prevent inundation from the river, and each house must be fitted with such conveniences. From these a three inch pipe must be laid to the street sewer, at an *uniform inclination* of at least 1 in 500. Into this three inch pipe the rain from the roof of each house must be conducted by suitable branch pipes, so that the rain may assist the house drainage. Of course the change of direction in these pipes must be made by easy curves.

The district south of the above, and which is more elevated, would have to be drained in a similar manner into the above reservoirs. And as the tide cannot flow through the sewers, I obtain water by damming up such brooks as may be intersected, and by causing a portion of their water to pass into the sewers.

The third object, viz., the prevention of the liquid in the sewers from filtering into wells, is attained by making all the sewers of watertight pipes.

Fourthly, the pollution of the river would be diminished if the impurities are washed into it, before they attain a state of fermentation or putrefaction. With this view pipes of such a diameter should be employed which, from their small size, would reduce the amount of air, to which the impurities would be exposed, to the smallest bulk practicable, and thereby diminish the chance of their fermentation; whilst the pipes should be large enough to admit a considerable volume of water, at such a velocity as would carry off all the impurities. And there would be a sufficient current in the river to convey them to the sea before they had time to putrefy in the river.

In the flat parts of the Metropolis the house drains frequently have no fall or inclination, in consequence of their being imperfectly built of brick, immediately under the floor of the lowest room in the house. On this account the impurities accumulate, ferment, and putrefy, and the stench from many of the shop cellars, from this cause, is extremely revolting. The alterations I have proposed to cure

this serious evil would be inconsiderable in expense but most effective in their object.

(Signed)

HENRY E. SCOTT,

Civil Engineer,

To the Commissioners of
Metropolitan Sewers.

14, Gray's Inn Square, London,
October 15, 1849.

GEORGE SHEPHERD Esq., C.E.

To the Commissioners of the Sewers of London.

Gentlemen,

IN addition to the document descriptive of my plans and sections, already deposited for the inspection of the *Court of Commissioners*, and in compliance with the resolution of the Court on the 3rd instant, I beg to forward this second communication, which is a concise description of my plans for improvements in the sewerage of the Metropolis; and on a careful examination will be found to possess the following desirable objects: viz.—

First. That the present main sewers already constructed, both on the Middlesex and Surrey sides of the river will remain unaltered, as the sewerage will be collected at the mouths, or outlets of these sewers, without coming in contact with the Thames water.

Second. That as the sewerage is generated in the Metropolis, it will be conveyed away without infecting the sewers, Thames, and surrounding atmosphere with its obnoxious gases, and unhealthy vapours, and the Thames water, so far as the sewerage is concerned, restored to its original purity.

Third. That these improvements give ample depth for the present and future drainage of the lowest locality in London, *and consequently confer an equal advantage on all parts of the Metropolis*; they are also capable of being flushed at any period, and the ingress and egress of the tide into the sewers are entirely prevented.

Fourth. That these improvements admit of a perfect system of sewer ventilation being established, and all obnoxious vapours being carried away as they are generated in the sewers.

Fifth. That in laying out these improvements the rapid increase of the population of London has been taken into consideration, and the dimensions of the proposed sewers laid down accordingly.

Sixth. That the solid matter will be collected and disposed of for manure, or the sewage in its liquid state, may, at such periods as are requisite, be conveyed to the required localities for irrigation, &c.

Seventh. That these proposed improvements can be effected within a period of *eighteen months*, without interruption to the ordinary traffic of the Metropolis.

Lastly. That an inspection of the plans will clearly show that but a small quantity of land will be required to be purchased to carry out these improvements.

The foregoing are the principal and main features of the project, and the details of the system are comprised in the following remarks:—

To effect these desirable objects, I propose for the sewerage on the Middlesex side, to select a locality below Blackwall, and on the other side of the river Lea, and there make a reservoir, say 300 feet long, 50 feet wide, and from 60 to 70 feet deep, (*i. e.* the ground admitting of these dimensions). This reservoir would be made as a tunnel, with a large shaft open to the surface, over which the steam power would be erected (marked A, plan I.) From this reservoir I propose to make a main sewer in the direction shown by the red line, which, it will be observed, passes under the River Lea, and in a line for the Commercial-road, near St. Ann's Church, Limehouse, Brook-street, New-road, Back-lane, Cable-street, Rosemary-lane, Tower-hill, and to the water side at the end of Lower Thames-street, (marked B); at this place the main sewer would be thirty feet below high-water mark.

The sewerage from densely populated parts of Whitechapel, Houndsditch, and Commercial-road, would be collected into this portion of the sewer, and conveyed to the engine station, A. This sewer, I propose, should be egg-shaped, fourteen feet high, by twelve feet six inches wide, and laid in with the best materials, (*i. e.* bricks and cement, the land springs carefully stopped out to avoid unnecessary pumping. This sewer might be put be put in as a tunnel, without disturbing the surface, excepting where shafts are required in the streets to facilitate the progress of the works). From the end of this main sewer at B, I propose to lay down a double set of egg-shaped cast-iron sewers, nine feet high, and seven feet wide; this double line of iron sewers to extend from the Tower-hill, B, to the Fleet Ditch sewer. The sewer nearest to the shore would take the Fleet Ditch and intermediate sewerage, as shown by the red lines on the plan, *a. b. c.* and *d.*

Plan II. is a view of the Thames from Southwark-bridge to Blackfriars-bridge at low-water, which shows the double line of iron sewers with iron branches from the inner sewer into the Fleet ditch and intermediate sewers.

The sections on the same plan show the method of connecting the iron with the present brick sewers, "*and the perfect isolation of the Thames water from the sewerage.*" From Blackfriars Bridge I propose to extend the other, or outer, sewer to Millbank prison, with branches into the intermediate sewers *e f g* and *h*, as before described.

From Millbank prison to extend also a cast-iron sewer to Battersea-bridge, and further if required, but of less dimensions, seven feet high by five feet six inches wide. This sewer would be of sufficient area for the sewerage of Brompton, Kensington, &c.

THE GRADIENTS OF THESE PROPOSED SEWERS.

In order to give ample depth for any such future main sewers as might be required to the ill drained localities, I propose to lay the bottom of the cast-iron sewers *at the spring tide low-water level at Westminster-bridge*, from whence I give the line of sewer an uninterrupted gradient of four feet per mile to the engine station (as shown in the longitudinal section for the Middlesex side, A B C, Plan I.) The above gradient has been recommended by the Imperial Commission of Architects in Vienna, and I have found from my own experience that this gradient is admirably adapted for rapidly conveying away sewerage and other waters, when in a high state of mechanical mixture; and I would here observe, that if less gradients are adopted, continual choking up of the sewers will be the result.

CONSTRUCTION OF THE CAST-IRON SEWER.

Plan II. shows the elevation, sections, and plan of the proposed iron sewers, which are cast in four parts or segments, and screwed together with iron bolts, both "horizontally and vertically," thus forming one continuous sewer; when laid down, it will be impossible for any part to sink, consequently no stoppage can occur from one part of the sewer sinking below the other.

And in order to give a greater degree of strength and security to the iron sewers, I propose to surround them with concrete, as shown in the Drawing II. This would protect the external surface from the action of the atmosphere, water, and mud, &c.

METHOD OF LAYING DOWN THE IRON SEWERS.

The above described cast-iron sewers I propose to lay down at a distance of thirty feet from the foundation of the buildings on the shores. As this portion of the river, and to a considerable extent beyond, being always dry at low-water, I should carry on the operations in the following manner:—"For each mile in length of iron sewerage required to be laid down, I should construct five moveable cofferdams, each one seventy feet long by thirty feet wide, and twelve feet deep; to each

dam would be attached a small steam-engine to pump out the water. Before fixing these dams in their required positions, the soft mud to the requisite extent would be cleared away ; the dams would, at high-water, be floated over these prepared places, and there weighted down ; when the tide had receded, clay would be deposited round the bottom of the dams, and the water stopped out. The operations of excavation and laying down the iron sewer would then be carried on inside the dams, independent of the rise and fall of the tide."

By the process above described I have successfully constructed 500 feet of sea wall for the formation of the Plymouth Great Western Docks, the foundations of which varied from four feet to fourteen feet below low-water mark ; *the excavations consisted of limestone, clay, and running sand*, the average cost did not exceed 4s. per cube yard ; the average cost of the excavations on the banks of the Thames would not exceed 2s. per cube yard.

And with five dams per mile placed at suitable distances, say 350 yards apart, 400 lineal of iron sewer could be completed weekly, without any obstruction to either *wharfs, warehouses, or steam-boat companies* ; or the whole of the iron sewerage could be completed in a period of from ten to twelve months.

SURREY SIDE SEWER DRAINAGE.

The sewerage on this side of the river I propose to treat in a similar manner to that on the Middlesex side before described ; namely, to convey it to a suitable distance from London. The situation I have selected for the engine station is below Greenwich, and from which I have laid down the direction of the proposed main sewer, shown by the red line E F H, Plan I., or which extends from the engine station through Greenwich (taking the Greenwich sewerage), and in a line to the Bricklayer's Arms, New Kent-road, St. George's-road, Lambeth-road, Church-street, and to the river side H, two branches of iron sewers could be extended to I I ; these branches would collect the sewerage from the outlets of the sewers that are already constructed in these localities. " From the late survey of London it will be observed that a central drain through these above described localities would be a most desirable object."

To collect the sewerage from the Thames side, I have laid down a branch, sewer from F, shown by the red line ; the direction of which is through Bermondsey-street, Tooley-street, and to the side of the Thames at L. From L to M, I propose to lay down a cast-iron sewer, seven feet high and five feet six inches wide, with branches into the present brick sewers already described. From these main sewers a series of small branches can be extended into any locality where drainage is required.

On Plan I., are shown the longitudinal sections of the proposed main sewer E F H, and branch sewer F L M.

It will be observed that the termination of each sewer (as laid down on the Plan I.) is at the sides of the Thames. At the termination of each sewer I propose to fix a valve. By this arrangement, the main or branch sewers might be flushed at any period.

When the rapid increase of the population of London is taken into consideration, dimensions less than I have laid down cannot safely be adopted. As these dimensions not only admit of ample space for the sewerage, but I propose to connect all the sewers with the engine chimneys (at the engine stations), and so draw off all the obnoxious vapours, as they are generated in the sewers, in the same direction with the sewerage ; and by this arrangement, *keep the whole system clean and well ventilated.*

THE DISPOSAL OF THE SEWERAGE.

The next question is the disposal of the sewerage. To effect this, I propose—As the sewerage is pumped at the engine stations, that it should be conveyed, in its liquid state, either in pipes or in a covered canal, to some suitable locality. The Middlesex sewerage, as I have shown on the Plan I., and the Surrey sewerage, to the Plumstead Marshes, where I would make several reservoirs ; each of these reservoirs should be made sufficiently large to hold the sewerage of twenty-four hours' pumping. These I would fill in rotation ; and when full, I would let the sewer water stand, say for twenty-four hours more. The solid matter in this period would subside. The supernatant liquid (unless a market could be found for it) could then, by means of flood-gates be let into the Thames at high-water, when it would be carried away with the tide, never more to return to pollute the river ; *but on no account should this liquid be let into the Thames at low-water ; this would prevent its being carried back to the Metropolis.* The solid matter so deposited in these reservoirs, might, at stated periods, be taken out and disposed of for manure ; or, should the sewerage be required in its liquid state for agricultural purposes, arrangements could be made for its conveyance to the requisite localities.

But the question of sending the whole of the sewerage into the country in its liquid state, requires some consideration. “ *What is to become of it when the crops are on the fields ; and in winter, frost, snow, &c. ? at these periods lands cannot be irrigated ; and what will be the expense of conveying the sewerage, say to a distance of fifty miles from London ?* But if the sewerage be conveyed to the place I have pointed out, its market value will no doubt soon be ascertained.”

STEAM ENGINE POWER.

The steam power required for both sides of the river should not be less than 700 horse power, *i. e.* 400 for the Middlesex, and 300 for the Surrey sides.*

The expense of carrying out these proposed improvements, from the calculations I have made, would not exceed £480,000.

REMARKS.

Numerous have been the suggestions for making a separate system of *drains* for the rain or surface water. This certainly might be done; *but the vast amount of animal excretiæ, washings of the filthy streets and market places, and the carbonaceous deposits* that certainly must, with every shower, go into the Thames, if this system be adopted,—These compounds cannot be less pernicious than the sewer water, and consequently ought not to be permitted to flow into the river; *and in order to avoid these nuisances, the expense of re-sewering London for surface water, and to meet the emergencies of heavy rains, i. e. when the steam engines become overpowered from excessive quantities of rain water (i. e. street washings):* To prevent this surplus water entering the Thames in London, I propose to make an *outlet, or surplus sewer, from each reservoir at the engine stations, to the sides of the Thames.* The dimensions of the outlet sewers should be the same as the main sewers. These sewers would be laid down at the neap-tide low-water-level. It is obvious that when the pumps at the engine stations were overpowered, that the surplus sewerage would find its way through these outlet sewers, into the Thames, but at a distance of from five to six miles from or below the Metropolis, carrying with it all the street washings, and other filthy substances; and at the same time, the sewers would be relieved of all undue pressure. These details are not shown in the plans; but I think that the above will be understood from the description.

The objects I have kept in view, in laying out these improvements, have been to effect the entire purification of the Thames water, in London and the immediate vicinity; also, to give sufficient depth in the "*proposed main sewers,*" for the perfect drainage of every locality in London, and to establish a perfect system of sewer ventilation, at the same time carrying off all obnoxious vapours (as they are generated in the sewers), in the same direction as the sewerage. If the system I have submitted be fully carried out, the purification of both air and water in the Metropolis, will be the result; and London might then be abundantly supplied with pure water from the Thames.

* The engines employed on the South Devon Railway, for the atmospheric apparatus, are admirably adapted for pumping purposes, and might be obtained from that Company at one-third their original cost.

It will be observed from the plans, that in carrying out these improvements, none of the docks, or other public works in London, will be interfered with, or yet the traffic interrupted.

I have the honour to be, Gentlemen,

Your obedient Servant,

(Signed)

GEORGE SHEPHERD, C. E.

26, Fleet Street, 17th October, 1849.

B. G. SLOPER, Esq.

THE plan I submit to the Metropolitan Commissioners of Sewers is intended only as a recipient system of sewerage, or to receive and carry away the sewage conveyed by the sewers to the Thames, and at present discharged into its waters. I take the existing system of sewerage, or of the sewers which will be constructed on a general and uniform plan, based on the Ordnance survey. I take the system as receiving and discharging both house and surface drainage.

I make a distinction between the north banks of the Thames, or Middlesex districts, and the south banks of the Thames, or Surrey districts.

On the north bank of the Thames, for about one mile above Kingston-bridge, I lay down stone-ware pipes, two feet diameter; I lay them two feet deep in the bed of the river, as high above low-water mark and as near to the bank as practicable.

I continue this tube to Strand End, where I place a small steam engine and duplicate of fifty horse power each, for the purpose of pumping the sewage, or drawing it through the tube from Kingston and the influents on the line with a velocity of 2 feet per second. [*Figures illegible in original manuscript.*]

I place a small reservoir at Strand End, for the purpose of holding a supply of liquid manure for distribution from this point.

I connect the reservoir at Strand End with a cast-iron tube of five feet diameter laid in the same manner in the bed of the river, and continued to Ranelagh Sewer, from which point I lay down two cast-iron tubes of five feet diameter each, and continue them through the Metropolis to a distance of eleven miles from London-bridge, or adjoining East Ham Level.

I connect the various outlets of the sewers, or such improved outlets as may be advisable with these lines of stone-ware and cast-iron tubes, and regulate the discharge of sewage into them by governing floats.

At the lower terminus at East Ham Level I place two steam engines and one duplicate of 250 horse power each, for the purpose of pumping the sewage through the double lines of tubes with a velocity of 2·5 feet per second.

By means of these pumping engines, I compensate for the insufficiency of the natural fall of the bed of the river, and obtain a velocity of 2·85 feet per second, which is sufficient to prevent any deposit in the tubes, and for the discharge of the whole sewage received into them.

At East Ham Level I place two great reservoirs, calculated to contain upwards of twenty millions of gallons of sewage.

The reservoirs, of which the drawing 2 shows one in section, are elliptical cylinders, terminated by semi-oblate spheroids. The lowest levels of their bottoms are eleven feet above low water mark, and their highest level of their crowns of their arches are four feet above high water mark. This allows the discharge of their contents to be commenced immediately on the ebb of the high tide, and the reservoirs to be entirely emptied of their whole contents in about an hour and a half after high water.

On the south bank of the Thames, from one mile above Kingston-bridge, I lay down a stone-ware tube of two feet diameter, and continue it to Vauxhall-bridge, where I place a small steam engine and duplicate of fifty horse power each, for the purpose of pumping the sewage through the tube, with a velocity of 2·045 feet per second.

As it appears to me that Mr. Austin's plan of a central sewerage is well adapted for the low districts on this side of the river, I have not proposed to carry the recipient tube farther than this point, but discharge the sewage into Mr. Austin's system of wells.

For the most part, the stoneware and iron tubes could be laid during the low water in the river. It would only be at the entrances to docks, canals, and small rivers that they would have to be laid in the bed always covered by water.

There are two points to which I beg to ask attention :—first, the means suggested to remedy the little inclination of the river's bed towards East Ham Level, and obtain a sufficient velocity of the current in the tubes ; and, second, the means for keeping the river water which ebbs and flows through the Metropolis free from the least taint of sewage for several miles from London-bridge.

On the first of these points, the fall or difference of level of the bed of the river

is very small; from Kingston to Mortlake the fall does not exceed 1.25 feet per mile; through the Metropolis the bed appears to be a dead level. The current of the sewage in the tubes would, therefore, be extremely sluggish, and the discharge so insufficient that the plan would be impracticable without an artificial means of accelerating the current. This I effect by pumping-engines drawing the sewage through the tubes at the rate of 2.5 feet per second, under the pressure of the atmosphere acting at the various influents, or junctions, of the sewers with the main recipient tubes.

In order to obtain a constant flow of the sewage from these influents, and prevent the entrance of air into the mains, I govern the discharge at each influent in such a manner that the area of the passage from the influent into the main varies in proportion to the fluctuating quantity of sewage at various times of the twenty-four hours. This I accomplish by a regulating float, shown in drawing 3.

The float is regulated to the minimum flow of the sewer, and rises as the quantity increased, allowing a larger area, or opening, for its passage into the recipient main.

Without some arrangement to effect this, the suction of the pumping-engines would not be continued beyond the first influent, but would draw in air; by this means the suction of the pumps will extend to the extremity of the tubes, and the flow at each influent be regulated by the pressure of the atmosphere on the liquid, and the area of the opening into the recipient main.

On the second point, the drawing almost speaks for itself.

I propose to keep the river water which ebbs and flows through the Metropolis perfectly free from a trace of sewage for about eleven miles below London-bridge.

This I effect by collecting the sewage in the reservoirs during the whole time of the flow of the tide, about $5\frac{1}{4}$ hours, and $5\frac{3}{4}$ hours of the ebb, and discharging it into the river immediately after high tide. The level of the reservoir suggested allows of its total discharge in about $1\frac{1}{2}$ hour. By this arrangement the water which has become mixed with the sewage will not, on its return with the flow of the tide, reach nearer than about eleven miles from London-bridge.

Although there is nothing very original in the plan I propose, it has the advantage of being very practicable and independent of casualties which, as in the case of the Thames Tunnel, might increase the outlay on a subterraneous tunnel to several times its estimated cost. As the pumping power will be less, also will the annual charge for the same be less, while the plan is visibly calculated to receive and collect the sewage of the various sewers for $32\frac{1}{2}$ miles along the north bank of the river, and

store it for agricultural distribution at two convenient points, or to reject it into the river in such a time and manner that it shall not contaminate the water flowing through the Metropolis.

I subjoin the calculation of estimates and formulæ, as serving to expedite their verification.

ESTIMATE.

	£
Iron tubes, at £10 per ton laid	407,700
Stone-ware tube on the north side	32,740
Tubes on the north bank	440,440
Stone-ware tube on the south bank	38,010
Total tubing	478,450
Three steam engines of 250 horse power each, and buildings	48,750
Four engines of 50 horse power each, and buildings	15,000
Two large reservoirs, brickwork	23,520
One small reservoir	2,500
Land	5,000
Earthwork at engine and reservoir stations . .	4,000
Junctions	25,000
	602,220
Contingencies, 10/00	60,222
Total	<u>£662,442</u>

(Signed)

R. S. SLOPER.

WILLIAM HENRY SMITH.—(W. H. S.)

THE physical aspect of London is such, as in its main features to present in the central district only hills; whilst on each side, east, west, and south, the land lies low.

The novelty of the system here recommended, consists in a combination of circumstances arising therefrom, and rendered artificially available, so as to give a natural rapidity of outfall.

I therefore, at one of the main central sewers as described, avail myself of the precipitate fall of the land from the Strand to the Thames, and at the river form a

stand-pipe to above high-water mark : thus giving increased force, and consequent outfall of four to six feet per mile. The natural outfall of the Metropolitan catchwater basin is the Thames : consequently, a line of sewers is formed at, or near the north and south side of the River ; that on the north side falling both ways, and therefore decreasing the size requisite.

I thus give a clear outfall to all existing sewers, the majority of which are now choked at flood-tide.

Exterior drains, as has been stated, circumscribe the Metropolis on all sides, and act as outlet sewers for the low-lying districts, and as catchwater drains for the upland floods ; thereby reducing considerably the size requisite for the sewers, which together with the other reductions herein explained, bring down the size requisite for each outlet sewer to the capacity of a stone or clay pipe.

The sewage is conveyed to four cardinal depôts, north, south, east, and west, or to one main eastern terminal depôt, where part is to be sold or exported in the solid, and the remainder in the fluid state : the surplus from the solid manure being employed for the irrigation of the marshes, and other lands contiguous to the depôts. All surplusage becomes filtered in its passage down the irrigating canal to the estuary of the Thames at Hollyhaven, which is too low for the tidal influence to convey it back to London.

The three minor depôts, in case of accident or receiving a surplus, have the means by flood-gates of diverting their sewage into the main, or eastern depôt. The entire sewage of the Metropolis is thus under immediate control without machinery ; it may converge on one point to supply increased demand, or become diverted.

The suburban districts on the Thames, or its tributaries above London, should be drained, and the sewage applied locally, and when the London sewage met sufficient sale, they could then, if thought advisable, be continued into the main, or Metropolitan arterial sewers.

I make use of all the existing sewers, dividing them vertically by York flagging, and separating the rain from the sewage, and the effluvium from the streets : the rain passing directly into the Thames, and the sewage being intercepted by the catchwater drains, thus giving a conjoint action to the entire capacity of the original sewers, in cases of the rain half over-filling by floods or flushing.

It will be seen that one of the chief features of this plan is convergence—convergence on the most economical system ; as, like the human frame, it has a minimum of channels, each only where most necessary, converging by seven different

courses to one main arterial or trunk tunnel of only two miles, through the Isle of Dogs, each of a size proportionate to their duties.

I recommend a peculiar, self-acting, and economical mode of simultaneous flushing from the cisterns, and the separation of the rain from the sewage of every house.

There are three alternative driftways under the Thames. Two of them would be for conveying the sewage from the southern depôt to the north, and *vice versa*.

If considered expedient to continue hydrostatic pressure beyond the Fleet, it will be necessary to divert that outfall by the third driftway to the sewer at the south side of the Thames. The principle, however, is efficient in operation without any driftway.

Finally, I propose all this to be self-acting, and without the costly, adventitious and dangerous contingencies of engine power.

(Signed)

WILLIAM HENRY SMITH.

WALTER SMITH, Esq.

“A time will come when plants grown upon a field will be supplied with their appropriate manures prepared in chemical manufactories,—when a plant will receive only such substances as actually serve it for food, just as at present a few grains of quinine are given to a patient afflicted with fever, instead of the ounce of wood that he was formerly compelled to swallow in addition.”—LIEBIG'S *Chemistry, in its Application to Agriculture and Physiology*. Third edition.

My Lords and Gentlemen,

ON the 24th ultimo I had the honour of transmitting to your Honourable Board a communication, somewhat in detail, exemplifying how the above prophetic declaration of Liebig might be speedily fulfilled, and thereby greatly promote the success of the present sanitary movement. To this communication I respectfully beg to call the attention of your Honourable Board, for further illustration of those principles and details, a concise account of which I herewith lay before you, agreeable to the resolution of the Court of Sewers held on the 3rd instant.

In the communication before alluded to, I stated at some length, what occurred to me as insuperable objections, both in a sanitary and economical point of view, to the disposal of fœcal matters through the medium of drains and sewers, however constructed; and that these difficulties can only be obviated by having an unlimited

supply of water, and a natural outfall, altogether independent of any mechanical appliances for its elevation at the terminus. Much more might have been said on this subject than I have there stated, but for brevity's sake I passed it over; and the like observation will apply to all the other statements therein contained.

The main features of my plan for dealing with fœcal matter, blood, &c., are these:—

First. I prevent their *decomposition* and *putrefaction*, as a general rule, and the exceptions are amply provided for as they occur on the instant.

All experience tends to confirm the fact, if once these substances are allowed to putrify, the consequences are—*intolerable nuisances, endless expense, and disastrous consequences to the health and comfort of mankind*. By my plan all these grave objections are entirely obviated.

Secondly. I restore night-soil, &c., to the land (its only proper receptacle) in its *normal condition*; or, at least, in combination with such substances as shall not only *prevent* any of its fertilizing properties from being lost, but as shall greatly *increase their efficacy*. All plans hitherto suggested, of dealing with this matter, assume decomposition to have taken place to a considerable extent; and by subsequent treatment *lose and dissipate* a considerable portion of its *fertilizing properties*; or by the ingredients which are mixed with it, in order to its removal, *its bulk is increased*, and its potency as a *manure diminished*, so as not to admit of its being sent a considerable distance in the agricultural districts. Having overcome these difficulties, I supply the agriculturists with a manure of *much greater fertilizing power* than night-soil itself, whilst its bulk is such, that 12 cwt. applied either by the drill or sown broad cast, will be a sufficient dressing for an acre, and will increase the productiveness of the land one-third. All objections, therefore, to sending such an important element of agricultural prosperity to the remotest districts—even to the *colonies*—are effectually overcome, and an unlimited market for the article secured.

In my communication of the 24th ultimo, I have given an approximate calculation of the profits accruing from the manufacture and sale of the manure, after paying all expenses for collecting the night-soil, &c., *from every house in the Metropolis, weekly*, which, though amounting to the large sum of £575,140. per annum, is far from representing the real money value of the whole; it amounts only to about 5s. per head on the entire population: whereas, very high authorities have calculated the money value of night-soil at over seven times that amount. Mr. Chadwick states, in his evidence before a committee of the House of Commons on the sewerage question, that it will amount to 10s. per head; whilst he further states, that its value in Belgium is estimated at £1. 17s. per head. My reason for taking so low a sum

as 5s. per head, is to enable the agriculturists to partake more largely of its real money value, so as to induce them to avail themselves fully to the extent of the supply, which an improved system of sanitary arrangements, founded on my plan, and embracing not only the entire Metropolis, but eventually *the whole of the kingdom*, will afford. There can be no doubt that the agriculturist would take *any quantity* which could be supplied at £3. per ton, and it is quite superfluous in me stating to your Honourable Board the immense advantage which agriculture will receive from such a source, thereby increasing the produce of the land under cultivation one-third; whilst it would enable a considerable breadth of waste land to be brought into cultivation yearly, with profit. I would further observe, that the manure is not a stimulating, and consequently *exhausting* application, but in every sense of the word, *a rich fertilizer*. And as the materials I employ are mainly derived from minerals, which, after undergoing chemical manipulations, are mixed with fœcal matter, they will tend to remedy some of the evils arising from the unequal distribution of geological formations on many soils. There are other important considerations in connection with my scheme, affecting the interest of *commerce, navigation, and locomotion*, which I can now only merely allude to.

The following is a brief statement of the details of my plan :—

In its application to the Metropolis, there would require about twenty different manufacturing establishments, having each one or more steam-engines of from 30 to 100 horse-power, according to the size of the district it would have to supply with the deodorizing and consolidating compound. I would divide the whole of the parishes of the Metropolis into districts, each containing 1,000 houses. There should be a depôt for each, where should be kept a supply of the compound, which would have to be distributed daily to the wagons appointed to call on each house once in the week to *supply the compound and take away the manure*, a portion of which would, the same day, be sent off direct to the farmers by railway and water, and the remainder sent to each of the manufacturing establishments which might be situate a short distance from the Metropolis, say, from six to twelve miles on every line of communication, both by rail and water. From these latter places, other agricultural districts may be supplied from time to time as required; and as all appearance of nuisance is removed, the objection urged against taking this substance away during the day and by railways is obviated.

The domestic arrangements for using the compound, will require the water closet to be entirely dispensed with, (which is, after all, *nothing better than a modification of the vile cesspool itself*, unless in connection with a running stream of water), and in its stead *a commode* will be required, into which a portion of the compound will be added after every time the latter is put into requisition. One pound and a half of the compound will be required for each individual per day, which will be sufficient to reduce the whole fœcal matter into a dry pulverent state,

divesting it of all putrid smell and noxious exhalations, and producing a greater degree of cleanliness than can be attained by any other means of dealing with fœcal matter.

A mechanical contrivance may be used if required, which will not be so liable to get out of repair as water-closets; the common privies may be used, with very slight modifications.

My plan also provides for the systematic carrying out of the scheme with proper arrangements for supervision, and suggests the mode by which a financial arrangement may be made for putting the whole into operation, through the agency of parish authorities, under the control of the Board of Health; and after paying all expenses, leaving a balance of near £600,000. per annum, for payment of interest on capital, and repayment of principal; after which, the price of the manure might be still further reduced, or the surplus applied in aid of the parish rates generally.

Such, my Lords and Gentlemen, is a brief outline of my plan of disposing of the main source of pollution to the habitations, atmosphere, and river, in connection with the Metropolis, and which is applicable to all cities and towns in the kingdom; and if put into operation, would render a much less expensive and complicated system of drainage than is at present considered requisite for more effectually accomplishing the sanitary purposes contemplated thereby. For more particular information on the different points submitted to the consideration of your Honourable Board, and for further elucidation of the subject generally, I beg again respectfully to refer you to my former communication of the 24th ult., and shall be most happy to give you any further information in accordance with the same which you may require.

I remain, my Lords and Gentlemen,

Your most obedient Servant,

(Signed)

WALTER SMITH.

MR. BENJAMIN STRATTON.

To the Metropolitan Commissioners of Sewers.

My Lords and Gentlemen,

In presuming to submit to your notice a plan for the speedy, effectual, and profitable removal of offensive matters from large towns, I would conciliate your attention by the preliminary remarks, that I have for several years given close and practical attention to the subject of the collection and distribution of manures—that the feasibility and value of the plans I propose may be ascertained by reference to existing institutions—and that these plans may be introduced *immediately, at a trifling expense*, and without prejudice to the future

adoption of the gigantic schemes proposed by other parties, should such be considered necessary or desirable.

I will first give a brief sketch of the plans I propose, with details of cost, &c., and will then refer to the advantages which I believe they possess over all others.

My plans consist, generally, in the daily or nightly collection and sending away of the liquid and solid human excrement produced during the previous twenty-four hours; treating the manure in detail, both in its collection and distribution, as being the most natural, the most economical, and the most productive mode of treating it. The manure from each house should be placed every night, secured in an air-tight vessel, in some place accessible to the collectors, who should cart it away in low close-bodied carriages, containing two tons each, to a water-side wharf provided for each district; where each cart load should be discharged into a close iron tank, containing rather more than two tons, a little charcoal or ashes placed in the upper part of the tank, and the cover fastened down. The tank full of manure then to be conveyed away as an article of commerce, and at a very low rate for freight carried by canal boats, for many miles, to those agricultural districts where it could readily be sold and applied in so portable a form.

With regard to existing nuisances in the shape of cesspools; stagnant drains, &c., &c., believing them to be most unnecessary and unmitigated evils, poisoning the air, and vitiating the water of the Metropolis, I would, wherever practicable, and as soon as possible, hermetically close them, until the pestilence which they have generated shall have passed away, and then in the least offensive manner that can be contrived (as for instance, by the use of Messrs. Deane's cesspool cleaner) thoroughly remove every particle of the putrifying matter they contain, and adopt every available means of purifying the contiguous soil from the pollution they have generated. Deodorising agents, irrigation, &c., may be most valuable for this purpose, and as a temporary remedy for existing evils; but anything short of the nightly removal of offensive matters, before they have had time to putrify, appears to be quite inefficient; and any plan which proposes to allow the sewage to pass through the same soil which is intersected by the springs, and water pipes, and open drains of large towns, appears most faulty in conception.

The plan I have to propose contemplates the *prevention* of all nuisances from the sewage, by the removal of it before it has been allowed to taint the air or the soil; and it is as feasible and cheap, as it is simple and effectual.

The liquid and solid excrement from each individual is calculated to be on the average 3lbs. per day. This would be received in each house, either in a species of portable water-closet, or in vessels with air-tight covers, not larger than the present

slop-pail, serving as receptacles for the matter passing through existing water closets. I consider that 3lbs of water would be necessary for each individual to serve partly as a deodoriser of the excrement during the day, and for purposes of cleanliness in the water-closet. If a larger quantity than this were used, provision might be made for a portion to pass off, without losing any of the liquid excrement which is the most valuable portion of animal manure. I consider that 3lbs. of water would be rather beneficial than injurious, when applied to the same weight of manure, and would render the article much less offensive, and more manageable than it would be without the mixture of this absorbent. The ashes of each house might be mixed with the manure without injury ; but I am informed that the ashes of some towns are at present a source of profit rather than a nuisance, being much sought for by brickmakers and others.

DETAILS OF THE PLAN AS APPLIED TO LONDON, but its extension to all other large towns will at once be obvious. In fact, all large factories, union houses, prisons, and other large collections of human beings, might thus readily contribute immensely to the public wealth.

Six pounds per diem for each individual in London will make about 2,500 tons to be removed every night. I propose having ten waterside wharfs for the reception of manure at carefully arranged distances, so that 250 tons would have to be received at each wharf every night, and this would take, allowing a spare cart for each station, 400 close-bodied carts, for the clearance of the sewage from the Metropolis every night. In attendance on these would be a man and two horses, hired by contract, and a trustworthy man in the service of the public body, to whom was intrusted this important undertaking. At each wharf would be required every night 125 manure tanks, holding about two tons each ; in all 1250 manure tanks for the whole city each night ; I propose having twenty days complement of these tanks, or 25,000, which would be ample, and allow of a profitable working of the system. Canal boats now penetrate inland to a distance of 100 miles in three days, so that the manure tanks might be taken to the various stations provided on the different lines of canal, remain on sale several days, be taken away by the purchaser to his farm, emptied, and returned again to London before they were required. If unsold within a certain time it might be emptied into reservoirs provided at the various stations by the Commissioners, deodorised and dried, and so become, in another form, a still more portable article of commerce. Or waste lands might be enclosed, and the unemployed poor engaged to dig trenches, in which the manure might be buried, and the land rendered productive.

Large depôts might be provided in central spots near London, so that the supply to the various localities might be regulated according to the demand ; there being no danger in allowing the manure tanks to remain in town ; for if the system

were properly worked, the citizen would wake each morning and find the city perfectly sweet; the noisome spirit of pestilence which is now devastating his home, being perhaps at his door, but as securely confined in its air-tight cell as the Genii of the Arabian Tale in their Iron Chest. And it is probable that large quantities would be shipped in London as return cargoes by vessels to distant lands, especially to our sugar colonies, and the sugar, tobacco, and cotton growing districts of America.

As to details of cost, &c., &c. The pails for each house would be found by the housekeepers, as at present the bins for holding ashes, &c. Or if found by the Commissioners, in order to ensure a proper construction, they would be paid for immediately, either by a rate, or any other desirable mode, and need not be reckoned in the calculation of capital required. I would however suggest that it would be advisable for the Commissioners to offer a premium for the best designs of portable water-closets and manure pans, so as to elicit a number of good and cheap designs for such articles.

In the drawing accompanying this letter, I have shown a form of portable water-closet, or rather portable cesspool, adapted to the purpose; but it must be obvious that no one settled form would be applicable alike to the smallest and the largest size of house; alike to the wretched, confined, and miserable habitations of the poor, and the splendid mansions of the great, the large hotels and club houses. Each class of house might have its own variety of portable cesspool, some on wheels, some merely with handles, some serving, while in use, the purpose of a water-closet, and this more especially in very poor houses, at present unprovided with this necessary article; while, in houses which already possess water-closets, the portable cesspool would be merely the recipient of their contents, instead of allowing them as at present to stagnate under the feet of the inmates, in their slow progress towards the street sewer.

The carts suitable for the purpose, and of which large numbers are in use for similar objects, in Manchester and elsewhere, are very durable and well fitted up, chiefly of iron, with close covers, and wheels five feet six inches in diameter, lessening the labour of draught. They are patented by Stratton, Hughes, & Co., of Bristol, and are delineated in the sketches accompanying this letter. They are called the Patent Tumbler Carts, from the effectual mode in which the body is tipped and the load discharged; and they are equally useful for collecting dust, ashes, slush, road scrapings, &c., as for nightsoil. The cost for a number of carts, of the size and strength desirable for London use, would be £30 each, and at an additional cost of £2 each they could be fitted with large copper pipes, and used in the day time for watering and washing the streets.

More than twenty of these carts, so fitted for general use, are now employed in Manchester, under the able superintendence of Mr. John Wallworth, the inspector

of the scavenging department to the Corporation of Manchester, to whose careful, impartial, and intelligent investigation of the merits of the cart, much is due of their successful operation in Manchester.

It is proposed to hire a pair of horses and a driver for each cart, so avoiding the objection of monopoly, and at the same time lessening the outlay and risk of capital required. This is the practice pursued at Manchester. The cost of a man and pair of horses per night in London, would be about 15s. There should be a careful man with each cart, in the pay of the Commissioners, whose duty it would be to assist in loading and unloading, and to be responsible for the work done in every respect; his pay would be 5s. per day. At each wharf twelve men would be required, at say, including foremen's wages, 5s. per day each. The wharves, of which I give a sketch, with small railway, &c., would cost about £3,000. each. The manure receptacles might be made of cast-iron, wrought-iron, copper, or zinc. I would recommend some of each being tried; but I think that cast and wrought-iron would both be useful; cast-iron for short distances, where the cost of freight would be very trifling, and the additional weight of the material no objection, and wrought-iron in other cases. The cast-iron tank would cost in quantities about £3. each; the wrought-iron about £5. I will reckon the whole number at £5, and these will form the principal item of expense; but I consider them most important to the proper carrying out of the plan, and most economical in enhancing the value of the manure by making it so portable. Now for the debtor and creditor statement of the plan.

FIRST FIXED CAPITAL.

400 tumbler carts, at £30 each	£12,000
12 wharves and warehouses, &c., at £3,000	36,000
25,000 manure tanks, at £5 each	125,000
Total first cost	<u>£173,000</u>

To allow of repairs and replacement of tools, I will allow 30 per cent. interest on this capital, in calculating current annual expenses; the account will then stand thus:—

EXPENSES PER ANNUM.

30 per cent interest on £173,000	£45,600
Hire of two men and two horses to each cart, £400 per night, or per annum, 365 nights	146,000
Twelve men at each wharf, at 5s. each per night, £36 per night, or per annum	13,140
Twelve superintendents, at £250	3,000
Carried forward	<u>£207,740</u>

Brought forward	£207,740
Fifty superintendents of country stations, at £200	10,000
100 clerks in town and country, at £100	10,000
One general superintendent and secretary	2,000
Two assistant secretaries, at £1,000	2,000
Twelve commercial travellers, and expenses, at £500	6,000
Expenses of advertisements, printing, &c. &c. &c.	10,000
Total cost of each year's production of manure	<u>£247,740</u>

I have been liberal in the allowances for agents, and superintendents, advertisements, &c. &c., as I think it desirable to introduce into public affairs the same principles which are found necessary to ensure success in private undertakings.

The secretary and under-secretary would exercise a general control over the system; and on the selection of properly qualified gentlemen for these departments, would in some degree depend the amount of profit to be realised by the concern. One of the under secretaries should manage the internal department, or the collection and storing of the manures, the providing of carts, utensils, &c.; the other the external department, or the sale and transport of the manures, the advertisements, direction of travellers, &c. &c. The chief superintendent or secretary having general control over the whole, and the receipt of monies.

I have reckoned nothing for expenses of labourers at the country stations, as the manure would be landed and storehoused by the canal companies; and should any remain unsold, the expense of deodorising would not properly belong to this account, as it would be devoted to the giving an increased value to the manure. I do not expect, however, that when the vast thinly peopled districts in the rich inland districts are made accessible to the manure, and the trade well opened by means of advertisements and travellers, that any would remain unsold longer than the fortnight, which the proposed stock of manure tanks would allow.

The advantage to the farmer, of being able to haul away, in his ordinary carts or wagon, without nuisance, two tons of such valuable manure, and deposit it immediately on his manure heap, increasing its value by the admixture, would be so highly appreciated, that a ready sale may certainly be depended upon. Contracts also might be entered upon, at a rather lower rate, with parties taking a regular supply periodically. The present consumption of artificial manures of less real value, and at very much higher prices, is enormous; and when the best of manure is offered at one-eighth of the expense, there is no doubt that it would be eagerly bought up in any procurable quantities. This would produce an immense income to the public, 30s. per ton being the lowest value that can be put upon the manure;

and allowing 10s. per ton on the average, for expense of conveyance by canal (a high average), we will reckon the nett available price of the manure at 20s. per ton.

The produce, 2,500 tons per night, or 912,500 tons per annum,
at £1 per ton, would realise £912,500

Or a nett revenue to the public, after deducting the ascertained
cost in every particular, of 664,760

And this while allowing 30 per cent. on the fixed capital required.

Supposing that the manure is worth, and would in a short time realise, £3. per ton, which it should do, when guano and worthless mixtures, so called, fetch from £10. to £13, per ton; the revenue would be £2,737,503, and the nett returns available for public use, £1,489,760, or say, in round numbers, a million and a half annually. If the same system were applied throughout the country, the annual profit would be at least £10,000,000.

I will abstain now, after so long engaging your attention, from any more detailed account of the plan I propose; this I shall be happy to furnish if required, but if the proposal I have the honour of suggesting meets with your approval, there are around you abler heads and more energetic hands to whom the carrying into practice of the plan should be entrusted.

I will now only allude very briefly to the advantages of the plan.

1. Its immediate applicability. Any ordinary house pail will serve at the present time for collecting the manure of each house. In three months the wharfs and the manure tanks might be completed by dividing the contract amongst several parties, and in the same space of time the requisite number of suitable carts could be supplied.

2. The absence of risk. Under this head I can only refer to the successful working of a part of the plan in Manchester.

3. The small outlay required. This is itself a great recommendation in the present state of trade and taxation; indeed the returns will come in so rapidly, that the outlay will be very trifling.

4. Its efficiency, for the want of which no cheapness could compensate: but in this particular it is far superior to any other, as it immediately removes away the matter that might become offensive, instead of allowing it to fester and putrify beneath our feet, and send up a most destructive remainder of its presence through every leaky valve of the million water-closets in London, and through every grating,

and other opening, which, whilst they admit water to flow off into the house drains and sewers, admit also of the escape of mephitic vapours to poison the atmosphere.

5. Its productiveness. Instead of lavishing daily upon a few square miles the excrementary produce of one-tenth of the population of the United Kingdom, it proposes to extend its advantages to the whole of the southern and midland counties of England and Wales, varying the supply to each district according to the demand, and so preventing the manure from being depreciated in value. In the foregoing calculation of cost I have estimated the marketable value of the manure much below its real value, and I have no doubt that in a few years, as the demand increases, manure would realize a nett price of ten pounds per ton, so that the revenue derived from this source would be a most important national gain, at the same time the inhabitants of this country would save annually many million pounds value of food, and new and varied sources of profitable employment would be opened up in every direction.

The drawings which accompany this letter are explained in the reference which follows; but I should wish it to be understood that I do not advance the details there shown with any undue presumption of their absolute superiority to other contrivances and modifications which might be introduced. What I chiefly claim as a new and fixed condition of my proposal is the principle of dealing with the sewage in detail, and more particularly the carting away at an early hour every day the solid and liquid excrement from every house in closely covered iron-bodied carts. An indispensable feature of my plan also is the transfer of the contents of the carts into suitable iron vessels, so as to make the manure up in convenient packages for distribution over the country.

These measures being proposed with reference to the Metropolis as it now exists, I think it unnecessary to go into the details of the plan as applicable to new houses and newly erected streets, &c. Suffice it to say, that all the evils which may at present be felt, and which will undoubtedly require some ingenuity to deal with them, may be entirely met by very simple provisions to be attended to in building future houses. This part of the subject I should be happy to enter on at any future time, should the remarks which I have already ventured to make, prove to be of any interest to your body.

I am, my Lords and Gentlemen,

Your very obedient servant,

(Signed)

BENJAMIN STRATTON.

Bristol, 26th September, 1849.

SIR THOMAS TANCRED.

Cirencester, Gloucestershire,

October 12, 1849.

Sir,

IN reference to your circular of the 5th instant, the slight sketch of a plan for conveying away the sewerage of the Metropolis, which I ventured to submit to the Commissioners of Sewers as a suggestion for the consideration of practical engineers, related only to the construction of a *main* sewer on each side of the Thames. My suggestion is, that a main sewer of sufficient dimensions to receive the house drainage (whether combined or not with the surface drainage), might be constructed on each side of the Thames, in the bed of the river, the bottom of such sewer being at or about the present low-water mark, and the masonry being carried up so as to form a quay on each side of the river above the main sewers, the space between the top of such quays and the present shores of the river being filled up level, and laid with rails, which might, perhaps, hereafter, be connected with the termini of the principal railways. The house-drainage would be conveyed into these main sewers by sub-mains, at proper intervals; the surface-drainage, if kept distinct, would be carried over the crown of the main sewers and discharged into the river. At the entrances of docks, and other places, where the quay would form an obstruction, the main sewer would be formed of an iron tube passing underground, and regaining its regular fall on the opposite side. The embankment of the river (besides the convenience and beauty of the quays) would secure the low-lying parts of the town from those inundations of the river which now so often cause great damage both to property and to health, and would probably tend to scour out and deepen the navigable channel of the Thames. Upon the security of the dues levied for goods landed on the quays, passengers, railway traffic, &c., money would be borrowed to purchase the interests of the present possessors of river frontage.

If the inflammable gases generated in sewers could be made available as a source of heat for steam boilers, &c. means might be readily devised for collecting them in reservoirs under pressure, and for consuming them through safety-jets, so as to obviate the danger of explosion; and thus perhaps another ingredient, at present noxious, may be converted to economical purposes, and the atmosphere of the Metropolis be thus purified, as its river will be, by the utilisation of the sewerage for agricultural purposes.

Not being qualified to enter into detailed estimates of the execution of drainage works, I submit, to those competent to judge of it, *the principle of combining main sewers, constructed in the bed of the river, with an embankment and spacious quays*, as exhibited in section in the sketch previously sent to your office,

And am,

Your obedient humble Servant,

(Signed)

THOMAS TANCRED.

To E. H. Woolrych, Esq., Greek-street, Soho.

MESSRS. TATE AND GILMORE.

Newcastle-upon-Tyne, October 11, 1849.

Dear Sir,

IN reply to the printed resolution of the Commission, received by us on the 8th instant, we beg to say that both our plans were sent to the Principal Office, Greek-street, before the 14th of August, and do not therefore come within the meaning of that resolution, which only requests an explanation of such plans as were presented after the 20th; nevertheless, we have great pleasure in complying with your desire, and would briefly observe, that our first plan's principal feature is the erection of *tall shafts* over the great trunk sewers (providing the present, or any similar, system of sewerage be continued), to carry off the deadly gases constantly arising from the ever present mass of animal and vegetable matter lying immediately below the surface of this densely-populated metropolis.

Each shaft having a powerful flame of gas inside, a few feet from the top, as a means of drawing the lighter foul gas from the sewers towards it, and rendering that foul gas harmless.

In connexion with that plan we recommended a good stench-trap, the design for which, if necessary, shall be submitted to your Honourable Court.

The main features of our second plan are — *simplicity, cheapness, and efficiency.*

1st. It can be applied with perfect *ease at once to any or all localities.*

2nd. Its cost would be less, and its efficiency a thousand-fold greater, than any system of sewerage with which we are acquainted—for,

Firstly. It will receive the animal and vegetable matter by a simple, safe, and direct mean, retain the same in the most pure and unadulterated condition, for any length of time, for agricultural purposes, in which state as a manure it is invaluable.

Secondly. It renders sewerage unnecessary, except for day-water and slops, thereby destroying the present system, which allows the great enemy of health, in all its frightful magnitude and power, to lie barely beneath the surface on which millions of human beings sleep.

Thirdly. It prevents the pollution of the air, the water springs, and the rivers and provides for the safe transit of a valuable manure to any part of the country, by the tank having four wheels for its removal to and by a railway, to be constructed for that purpose, or (by separating the tank from its own carriage) by trucks, on any

railway, or by ship, in any quantities, to any part of the sea when not required by the land.

Fourthly. It obviates all ripping of streets, stoppage of thoroughfares, secondary removals, offensive sights, injurious or offensive smells, all necessity for levelling, engine-forcing, &c. &c.

Fifthly. An iron tank ash pit, such as we recommend, on four wheels, would complete the matter, by receiving all kitchen refuse through a slide door-way, said door to shut of itself, to prevent unpleasant exhalations, &c., and when the tank was filled it would be removed, *instantly*, without injury to place or person, to any part of the country.

We have the honour to remain,

Your very obedient servants,

(Signed)

TATE & GILMORE.

To E. H. WOOLRYCH, Esq.

Sec. M. S. C.

JOHN TEBAY, Esq., C.E.

To the Right Honourable and Honourable the Commissioners of Metropolitan Sewers.

My Lords and Gentlemen,

IN compliance with the resolutions passed at the Court of Sewers held on the 3rd instant, I beg to lay before you the following "Concise Statement" of the plan which I propose for the effectual drainage of the Metropolis, which plan is more fully described in my paper already lodged at the Office of Sewers, and bearing date the 29th of September, 1849.

In order to secure the three essential elements of simplicity, efficiency, and economy, I propose the construction of,—

TWO MAIN TRUNK SEWERS, on the north and south sides of the river Thames, respectively. These sewers to have a parabolic sectional form; to be so arranged as to receive the whole of both land and house drainage at present flowing into the Thames between Putney-bridge and Greenwich-reach; to be of sufficient depth to drain the lowest parts of the Metropolis; to have *one uniform fall*; not to interfere with the arrangement of existing sewers further than is necessary for their connexion and for efficient drainage; and to be of sufficient capacity to allow for the probable extension of the Metropolis during the period required for the re-payment of principal and interest by an annual rate. The *course* of these two main sewers to be taken

under a certain line of streets, in order *to obviate the necessity for compensation*. The sewage to be elevated to the surface from the level of the outfalls by suitable machinery, and disposed of for manure.

SUBURBAN DISTRICTS, lying westward of Putney-bridge, such as Barnes, Mortlake, Kew, &c.; and to the eastward of the river Lea, as Plaistow, Barking, &c.; to have each its own system of sewerage and manure depôt at present; but so arranged as to be connected with the above-named main trunk sewers at a future time, should the Metropolis extend so as to include these places more immediately within its limits.

MANURE DEPÔT to be constructed at the outfall of each main trunk sewer, with *filtering tanks*, for the purpose of concentrating the solid matter contained in the sewage. Provision to be made for discharging the superfluous liquid portion, after being deprived of its deleterious qualities, when necessary and at proper times, into the Thames, at a point which would ensure its being carried off. The sewage to be supplied as manure to purchasers in either its crude, a filtered, or a solid state; and conveyed away, as demand arises, in casks, bags, or other vessels, so that the use of it may not be confined to the immediate locality, thereby limiting the market for its sale.

FLUSHING, in a systematic and competent manner, essential to the cleanliness and efficiency of any extended system of sewerage. *Partial flushing*, especially with the present system of ventilation, dangerous and most reprehensible. Suitable *underground flushing tanks, or chambers*, to be constructed at the head or source of each main line, or branch sewer; to be supplied with water from the land drainage; or, when necessary, from the street water mains. All *gullies* to be provided with a *flushing, or scouring-pipe, and valve* connected with the street mains. The application of a simple, but effective contrivance, for preventing the *backing of the sewage* into small branch and house drains, during the operation of flushing.

TRAPPING OF EVERY INLET to drains or sewers indispensable. The hydraulic trap, in form of a letter S, has been proved to be simple, and more efficacious than any other plan of trap that has yet been invented. All traps to be placed at the *inlets* to drains, and not at any intermediate point, or at their *outlets*.

VENTILATION of sewers scarcely less important than trapping, especially those capable of admitting a man. All accessible sewers to be constantly under the supervision of competent officers, whose duty it should be to report, periodically, upon the state of the various districts, and to see that all connexions of house and other drains, with the main or branch sewers, be made in a proper and efficient manner. All the present *street level air-shafts* to be closed up, and proper down-cast shafts, at suitable

points, in the form of an obelisk, or other useful or ornamental form, to be constructed, so as to admit a current of air *into* the sewers, at a point at least ten feet above the level of the street. Each air, or downcast shaft, to have a valve or flap for regulating the current of air to be admitted. *A constant current* of air to be maintained in the whole of the sewers by rarefaction, by means of furnaces at the outfall of each main trunk sewer; these furnaces to be economically applied to certain other purposes at the same time.*

WATER SUPPLY, on an extensive scale, also indispensable. The construction of sewerage water-works suggested. Supply might be taken from any convenient point of the Thames, as the quality of the water required for sewerage purposes is of little importance. These water-works would also provide for the extinction of fires without the aid of fire-engines. A considerable quantity of water would be saved, for domestic purposes, by the establishment of separate works, instead of trenching upon the present supplies.

COST OF CONSTRUCTING the two main trunk sewers, inclusive of the connecting of all the present sewers therewith; also the trapping and ventilating of the present sewers, not to exceed £535,184, which sum would be repaid with interest in twenty-two years, by an annual rate of $1\frac{1}{4}d.$ in the pound upon all property drained.

SEWAGE MANURE has not been sufficiently used, as yet, to afford any sure data from which to estimate the value of the Metropolitan sewage; but the effectual removal of the sewage, irrespective of its value, is an object of sufficient importance to warrant the proposed outlay.

SURVEY of the existing sewers, with their courses, rates of inclination, direction of fall, capacity, levels of their outfall above or below Trinity high-water mark, &c., required, before any *properly detailed plan* can be drawn up.

* I would here remark, that since the drawing up of my plan, an accident has occurred in Friar-street, which may tend to throw discredit upon the system of ventilating by rarefaction; but I venture to assert, that either gross ignorance of the system, or great carelessness, must have existed somewhere, else the explosion alluded to could not possibly have taken place. I have experienced its efficiency in the extensive ventilation of *coal mines*, where constant disengaging of carburetted hydrogen gas is going on, and have never known a single instance of explosion attributable to the system of ventilation by furnaces. By a *proper* admission of atmospheric air, the hydrogen becomes diluted, and its inflammable properties destroyed. It ought also to be considered that if once the system were established, there could not by any possibility be an *accumulation of explosive* gases in the sewers, even assuming that they are *generated* to any appreciable extent therein; a circumstance which, to say the least, is very doubtful.

One great advantage of such a system of ventilating sewers, is that the heat required to cause rarefaction can be economically applied to the boilers of the steam-engines required to raise the sewage from the level of the outfalls.

Having given this brief description of the main features of my plan, I have only to add, that I am ready to go into detail, should the required data be afforded, and sufficient time given; or, should any of the features of my plan be deemed worthy of being combined with others, in order to form the best general plan that present circumstances will admit of being carried into effect, I shall be happy to co-operate with the author or authors thereof.

I remain,
My Lords and Gentlemen,
Your very obedient Servant,

(Signed) JOHN TEBAY,
Civil Engineer.

Aldine Chambers, Paternoster-row,
October 17, 1849.

C. HARCOURT WHITE, Esq.

No 11, Oak Cottages, Hammersmith.

Sir,

I HAVE the honour to acknowledge the receipt of your circular, dated 5th October, and in answer beg to forward you the following concise statement.

My ideas concerning the draining of the Metropolis are as follows :—

To make use of the sewers now in existence.

And conceiving that the formation of two new main sewers, sunk at a depth to receive the drainage of the district to which they each pertain, running parallel with, and as near to the river as practicable, communicating with it at both ends, the upper one to receive the river water, as a scouring power, and the lower to re-deposit the sewerage either in barges or the river itself, would be objectionable in a matter of time and expense, I would suggest that the sewerage water now running into, and polluting the river, should be received where possible, and where not, pumped into barges, in the manner described in my letter, dated Sept. 19th.

I have the honour to be, Sir,
Your most obedient Servant,
(Signed) C. HARCOURT WHITE.

E. H. Woolrych, Esq.

Oct. 8, 1849.

JOHN WILKINSON, Esq.

No. 10, Devonshire-place,
King's-road, Chelsea,
Oct. 11, 1849.

Sir,

I CONSIDER the main features of my plan for the drainage of the Metropolis to be, First, the carrying away of all filth from houses by means of drains into the common or nearest sewer, as conducive to health and cheaper than the present mode. Second, the reception of it into tanks or cesspools,—a better plan than its running into the river,—and that it might be sold as manure. Lastly, that if properly adopted at once, there need not for years be any fresh expense.

I have the honour, &c.,

Your obedient Servant,

E. H. Woolrych, Esq.

(Signed) JOHN WILKINSON.

Mr. S. WISE,

THIS tunnel is of compound form, being divided in the centre, from the bottom to the springing line of the upper arch, by a partition wall; upon this is a series of strong, semicircular arches, supporting the middle of a wide elliptical formed arch, which spans both divisions.

The reasons adduced for a double tunnel are various; amongst the principal is, the almost utter impossibility of repairs being executed in a single tube. By the present plan, the tunnel furthest from the shaft entrances will be a “*reserve*” tunnel for this purpose; so that if works are required to be done, and at one, or several places, to proceed at the same time, they can be effected precisely in the same way that a length of road is repaired: the traffic for a short space is turned aside until completed, after which the barriers are removed, and the direct thoroughfare again opened. Water-gates placed at intervals in the division wall, will enable the sewage to be directed into the reserved channel, and back again as desired.

Another important object attained by a double tunnel for a main basement sewer, is when an influx of water occurs. At any determinable height an overflow can be at command, and enable the surface water to discharge itself into the reserved channel.

The crown of the chief arch being carried by the division wall, will render the tunnel of easy construction, and no engineering difficulties are to be apprehended but that will be readily overcome.

The shaft represented in the margin (*see original manuscript*), is one of that general kind, of which many will be required.

It is divided into two compartments, the wet and the dry, by a brick wall. The wet division for water delivered from the sewers, and by it conducted to the lower part of the main tunnel, falling from a projecting drip-stone at the mouth of the sewer above, upon a splash-stone fixed at an angle of 45 deg.; from the rebound, the water will propel itself through to the main tunnel by a channel, also at the angle of 45 deg. as shown by the darts. It is in this manner that we propose the sewage to be conveyed (in accordance with the well-known law of the angles of incidence and reflection) from such of the old sewers that are found can conveniently be made tributary, and cutting off, in these instances, their further approach to the river Thames. It will be perceived the dry compartment is that which is invariably the nearest to and entering the upper part of the main tunnel or basement sewer. It is for the sewer-workmen, implements, and materials required in repairs, and for ordinary examinations of the lower works.

The upper part of the shaft under the ground, is built square, and the paving above supported on stone landings upon iron bearers, and iron folding doors over the man-holes, closely fitted and made air-tight. Sufficient headway for the workmen in this room, is a machine for lowering and raising materials up and down the shaft, made to pass over to either the wet or the dry division of the shaft by a tram-way. Stone landings to cover the spandrels at each corner, and space allowed for the materials to descend. Iron step-ladders of the ordinary construction, placed from the top to bottom, on each side of the division wall, and the mouth of the sewer can be visited from the wet division. A tram-way, fixed upon brackets, placed at the level of the springing of the principal arch of basement sewer in both tunnels, will enable the sewer to be inspected, or workmen and materials to be carried by a small machine, with ease, in the same way as materials are conveyed to and fro in the New Prison at Pentonville and similar buildings. It can be propelled by the hand, as shown, or by means of a rope. If the rail be kept parallel to the fall of the sewer, the materials brought from the higher levels will secure the advantage of the incline for the load, and the back carriage for the empties.


It is proposed that these shafts shall be made available for the boring and supply of artesian spring water; much expense will be saved thereby. The water will be of service for the works during the construction, and can be obtained at after times, being supplied from a hose attached to the rising main for repairs, &c. However, for repairs we strongly recommend the use of Seyssel asphalte; the bottom of the main sewer and the wet shaft should be built of stock bricks, asphalted after the method recommended and adopted by the Company, and at any time repairs can be effected in a sound manner by this material, which is what cannot be done by any water-

cementing; a proof of its utility in water-works can be witnessed by reference to the large reservoir, executed for the New River Company, upon Highgate-hill, and many other works.

To save obstruction caused by the shafts, they should be kept as much as possible out of the leading thoroughfares, and to save expense, it is better not to tunnel under the Thames. We have traced a general idea of a course, but it is open to further investigation; moreover, we opine short lengths in certain localities, in preference to branches into the "trunk lines" of basement sewer; these will be less in size, and no more expense incurred, and a great advantage will be gained in the manure being better distributed around the country.

The working shafts used in the progress of building, and which are commonly stopped and domed over, to be left open, and tall chimnies built thereon. It is not likely with this vent for the foul air, that it will struggle to escape through the sewers and upper drains. Wherever the lines of main tunnel terminate, suburban reservoirs with dredging machines, and manure pumps in two sets and divisions are to be so placed that either compartment of the reservoir can receive the sewage from either tunnel, so to effect an interchange to admit of repairs of machinery, or for the extra lifting that may be occasionally from an overflow.

By the above means the manure will be available for the purposes of agriculture, and this is as far as this imperfect description can extend.



Metropolitan Sewers.

SECOND SERIES.

CONCISE STATEMENTS

OF

THE MAIN FEATURES

OF

THE PLANS

FOR

THE DRAINAGE OF THE METROPOLIS.

SENT IN PURSUANCE OF THE RESOLUTION OF
THE COURT, 20TH AUGUST, 1849.

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